DOCUMENT RESUME

ED 044 190 RC 004 211

TITLE	Industrial Location Research Studies: Reports 9-16.
INSTITUTION	Fantus Co., Inc., New York, N.Y.
SPONS AGENCY	Appalachian Regional Commission, Washington, D.C.
REPORT NO	ARR-6
PUB DATE	Dec 66
NOTE	278p.
AVAILABLE FROM	The Fantus Company, Inc., Fantus Area Research Division, 430 Park Avenue, New York, N.Y. ($2.50)
EDRS PRICE	EDRS Price MF-$1.25 HC-$14.00
DESCRIPTORS	*Economic Development, *Industrialization, Machinery Industry, *Manpower Utilization, Manufacturing, Metal Industry, *Regional Planning, *Rural Areas, Vocational Education
IDENTIFIERS	*Appalachia

ABSTRACT

Eight studies identify, examine, and evaluate significant elements of industry-location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian region. Examined in the document are the chlor-alkali industry; the manufacturing of trucks, tractors, etc.; the mobile-home and special-purpose-vehicle industries; the instruments and controls industry; the synthetic-fiber industry; the metal-stampings industry; the aircraft- and aerospace-parts industry; and the primary-aluminum industry. As necessary background, the document presents information on the structure of each industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis, as noted, is on trends now shaping industry growth rather than being on historical developments which no longer may be significant in the outlook. Additionally, vocational training is seen as playing a significant role in selecting public investment facilities which will enhance the competitive position of Appalachia. (Related documents are RC 004 206 and RC 004 210.) (EL)

APPALACHIAN RESEARCH REPORT

RESEARCH REPORT NO. 6

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INDUSTRIAL LOCATION RESEARCH STUDIES:

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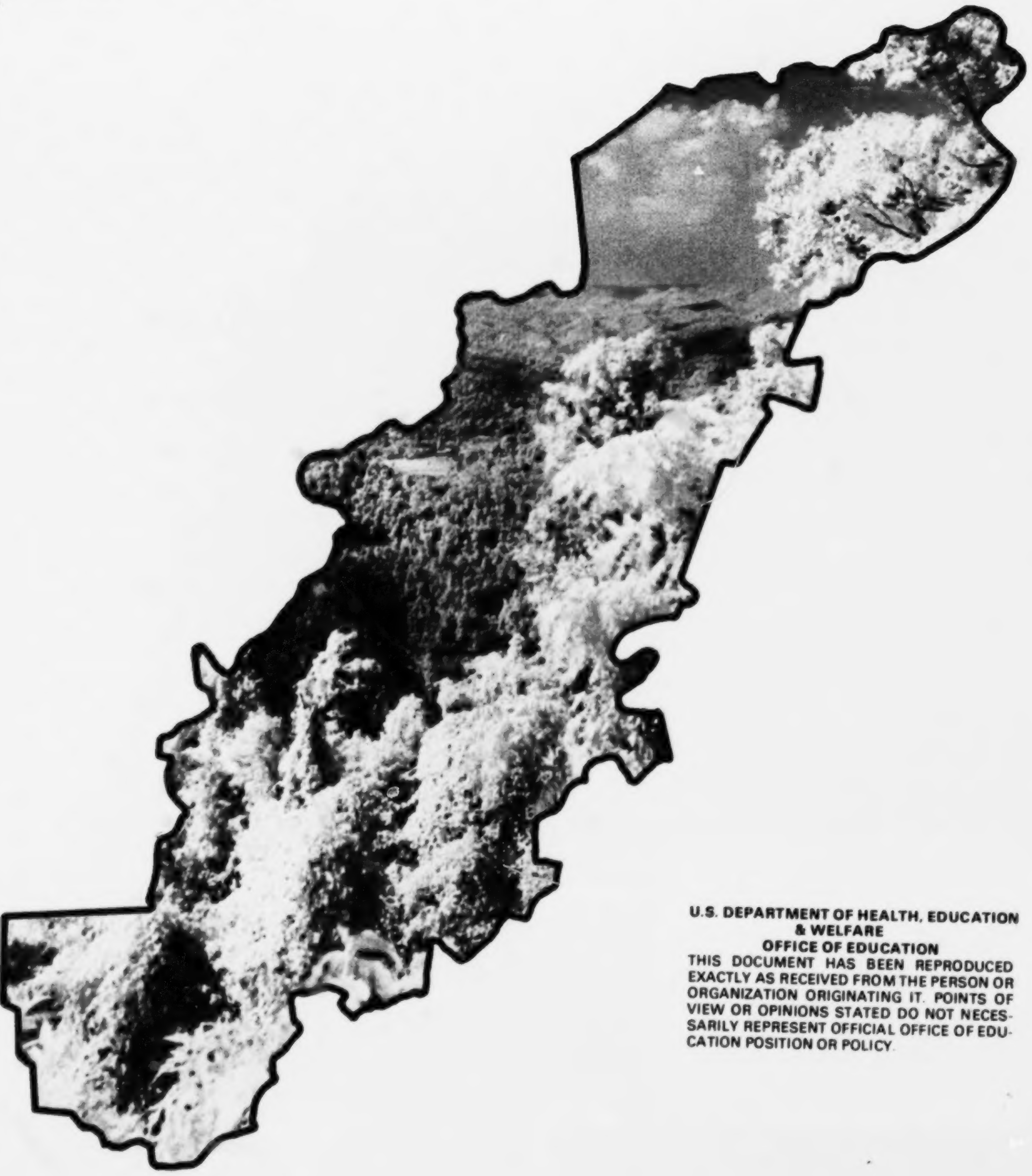

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Prepared For The Appalachian Regional Commission
By The Fantus Company, Inc.

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REPORT NO. 1—THE PAPER AND ALLIED PRODUCTS INDUSTRY
REPORT NO. 2—THE TEXTILE MILL PRODUCTS INDUSTRY
REPORT NO. 3—THE APPAREL INDUSTRY
REPORT NO. 4—THE PRINTING AND ALLIED INDUSTRIES
REPORT NO. 5—THE ELECTRICAL COMPONENT PARTS INDUSTRY
REPORT NO. 6—THE TEXTILE MACHINERY/PUMPS & VALVES INDUSTRY
REPORT NO. 7—THE OFFICE MACHINERY INDUSTRY
REPORT NO. 8—THE MOTOR VEHICLE PARTS INDUSTRY

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REPORT NO. 9—THE CHLOR-ALKALI INDUSTRY
REPORT NO. 10—MATERIALS HANDLING EQUIPMENT
REPORT NO. 11—THE MOBILE HOME AND SPECIAL PURPOSE VEHICLE INDUSTRIES
REPORT NO. 12—THE INSTRUMENTS AND CONTROLS INDUSTRY
REPORT NO. 13—THE NONCELLULOSIC SYNTHETIC FIBER INDUSTRY
REPORT NO. 14—THE METAL STAMPINGS INDUSTRY
REPORT NO. 15—THE AIRCRAFT AND AEROSPACE PARTS INDUSTRY
REPORT NO. 16—THE PRIMARY ALUMINUM INDUSTRY

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REPORT NO. 18—THE MALLEABLE AND DUCTILE IRON CASTINGS AND STEEL FORGINGS INDUSTRY
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REPORT NO. 20—THE ROLLING, DRAWING, AND EXTRUDING OF NONFERROUS METALS INDUSTRY
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REPORT NO. 24—THE PRIMARY STEEL AND STEEL MILL PRODUCTS INDUSTRY
REPORT NO. 25—THE PLASTIC RESINS, ADHESIVES, AND RELATED COMPOUNDS INDUSTRY

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Reprint of Reports Prepared for the

Appalachian Regional Commission
1666 Connecticut Avenue NW.
Washington, D.C. 20235

by

The Fantus Company, Inc.
Fantus Area Research Division
430 Park Avenue
New York, New York

December 1966

RC004211

APPALACHIAN RESEARCH REPORT NO. 6

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such industry, specifically Standard Industrial Classification industry code 2812, Alkalies and Chlorine.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

Chlor-alkali production provided employment for close to 20,000 workers in 1964. Shipments exceeded $567 million, with chlorine and caustic soda accounting for 73.1 percent of the total. A total of 39 companies operate 98 chlorine-caustic and soda ash plants, dispersed over 28 states. The Appalachian Region claims a total of 9 chlor-alkali plants.

Chlorine and caustic soda production has grown at an annual rate of 8.7 percent over the past 5 years. Production now stands close to 95 percent of capacity and there is a general tightening in the supply position. Industry experts predict an annual growth in consumption at the rate of 7.0 percent for chlorine and 5.0 percent for caustic soda. However, the market research group of a leading contractor predicts new plant investment of over $450 million will be necessary to meet the 1970 U.S. demand.

Markets orientation prescribes the broad overall geographical boundaries for new plant locations. Within this framework, manufacturers will seek to optimize costs through the effective balancing of transportation, power, and raw material considerations.

Accordingly, public activities, investment, policies and actions should be directed toward programs designed to: (1) create power rate structures competitive with TVA; (2) improve and extend the inland waterway system; (3) speed the completion of Appalachian highway corridors and improved feeder systems; (4) foster extension of rail service into new areas suitable for chlor-alkali production; and, (5) provide flood-free sites, on rivers with controlled flow.

I. PROFILE OF THE INDUSTRY

Size

In comparison with other nondurable goods production, the chemical industry ranks fifth in employment, second in terms of value added by manufacture, and led the field in new capital expenditures (see Table 1).

Table 1.

Rankings of the nondurable goods industries, 1964 1/

(numbers in millions)

Industry Rank	Employment		Value added by manufacture		Capital Expenditures	
1	Food	1.6	Food	$23,054	CHEMICALS	$1,876
2	Apparal	1.3	CHEMICALS	19,133	Food	1,419
3	Printing	0.9	Printing	11,065	Paper	886
4	Textiles	0.9	Apparel	8,150	Textiles	492
5	CHEMICALS	0.7	Paper	7,805	Printing	463
6	Paper	0.6	Textiles	6,736	Petroleum/ coal	412
7	Rubber/ plastics	0.4	Rubber/ plastics	4,984	Rubber/ plastics	400
8	Leather	0.3	Petroleum/ coal	3,774	Apparel	124
9	Petroleum/ coal	0.1	Leather	2,270	Tobacco	59
10	Tobacco	0.08	Tobacco	1,772	Leather	38

1/ Source: 1964 Annual Survey of Manufactures, U.S. Department of Commerce.

The chlor-alkali industry (SIC 2812) accounted for shipments in 1964 amounting to $711.6 million, representing 5.9 percent of industrial organic and inorganic chemical shipments (SIC 281) and 2.1 percent of the total shipments originating in the chemical and allied products industry (SIC 28). Chlor-alkali employment (as measured by the Bureau of Census) was 19,927 in 1964, and value added by manufacture ran to over $436 million.

Products and Markets

The relative significance of individual chlor-alkali product classifications is demonstrated in the following table:

Table 2.

Value of selected product shipments 1/

Product Class	Value of Shipments ($ million)
Sodium hydroxide (caustic soda)	243.9
Chlorine, compressed or liquefied	170.8
Sodium carbonate (soda ash)	130.1
Other alkalies	22.8

1/ Source: 1964 Annual Survey of Manufactures

Chlorine and caustic soda are coproducts derived from the electrolysis of a salt-saturated brine, and account for over 73 percent of the total industry (SIC 2812) shipments.

The production of organic chemicals now accounts for close to 70 percent of chlorine consumption. Another 10 percent goes to the plastics industry and the remainder is spread among pulp and paper, inorganics, and water treatment. Moreover, two recent developments hold out the possibility of substantial new consumption. New requirements for titanium metal create the need for new titanium tetrachloride capacity. Secondly, the sulfuric acid process utilized in the production of titanium pigments is undergoing increasing displacement in favor of the chloride method.

Less than one-half the production of caustic soda finds its way into the chemical industry. Pulp and paper, and rayon manufacturing, each requires approximately another 10 percent; aluminum, textiles, petroleum, and soap follow in that order.

Soda ash (sodium carbonate) finds its major and fastest growing market in the glass industry, which accounts for over 40 percent of total consumption. The other major soda ash markets, including pulp and paper, soap and detergents, and aluminum are rather static or declining as manufacturers increasingly substitute caustic soda.

Plant Ownership and Size Structure

According to latest census statistics, 19 manufacturers are operating the 38 U.S. establishments producing chlor-alkalies. However, the figures are misleading in that they include only those establishments primarily engaged in manufacturing these products. They do not account for the captive production maintained by large consumers in the pulp and paper, glass, and chemical industries. Thus, a more comprehensive and current indication of the industry composition is provided in the Directory of Chemical Producers as published by Stanford Research Institute. This source indicates that 1966 production of chlorine, caustic soda, and soda ash involved 39 companies operating 98 plants.

The leading producer claims over 35 percent of the total chlorine and caustic soda production capacity. Combined, the 4 top companies control 58 percent of capacity; and, with the additional next 2 largest producers control extends to over 70 percent.

In terms of employment, 1965 establishments (as measured by the Census of Manufactures) fell within the following ranges:

Employment Range		Number of Plants
1- 19		1
20- 49		1
50- 99		9
100-249		10
250-499		4
500-999		7
1,000 or more		6
	Total	38

Geographic Prevalence

In total, 28 states can claim a representative of the chlor-alkali industry, while fully one-third of these boast 4 or more establishments. Table 3 presents the actual plant distribution by state.

Table 3.

State and regional distribution of chlorine, caustic soda, and soda ash establishments 1/

State	Number of Establishments	State	Number of Establishments
NEW ENGLAND	(6)	EAST SOUTH CENTRAL	(12)
Maine	5	Alabama	6
Rhode Island	1	Kentucky	2
		Mississippi	1
MIDDLE ATLANTIC	(11)	Tennessee	3
New Jersey	2		
New York	9	WEST NORTH CENTRAL	(1)
		Kansas	1
SOUTH ATLANTIC	(16)		
Delaware	1	WEST SOUTH CENTRAL	(23)
Georgia	2	Arkansas	1
Maryland	1	Louisiana	11
North Carolina	4	Texas	11
Virginia	5		
West Virginia	3	MOUNTAIN	(4)
		Nevada	1
EAST NORTH CENTRAL	(14)	Wyoming	3
Illinois	1		
Michigan	6	PACIFIC	(11)
Ohio	5	California	5
Wisconsin	2	Oregon	1
		Washington	5

1/ Source: Directory of Chemical Producers, Stanford Research Institute, Menlo Park, California

The Middle Atlantic, South Atlantic, and East South Central districts, when combined, account for 40 percent of the total U.S. plants.

Appalachian Specialization

Appalachia's specialization in chlor-alkali production is reflected in Table 4. The area accounts for a respectable portion of current capacity, and 2 of the 4 industry leaders maintain 4 separate facilities in the region.

Table 4.

Appalachian establishments and production capacity 1/

State	Number of Plants	Annual Capacity (thousands of tons) Chlorine	Caustic Soda	Soda Ash
Virginia	1	81.0	237.6	360
West Virginia	3	501.6	573.3	-
North Carolina	2	20.2	23.1	-
Tennessee	1	63.0	72.0	-
Alabama	2	129.6	148.1	-
Total	9	795.4	1,054.1	360
% of total U.S.	9.2%	10.4%	11.6%	4.8%

1/ Source: Directory of Chemical Producers, Stanford Research Institute

Economic Impact

The chemical and allied products industries create 2.2 percent of the total national income and 18.8 percent of the national income originating in nondurable manufacturing, as determined from the U.S. National Income and Product Accounts for 1965. In 1965, production of alkalies and chlorine involved approximately 23,000 employees. The 16,000 production workers earned in excess of $109 million, with average earnings 38.5 percent greater than the overall nondurable average.

A further indication of the industry's impact can be derived from analysis of the interindustry (input-output) tables. Purchases from direct suppliers are related to $1,000 of chemical industry gross output in Table 5. Moreover, every 4 additional direct employees will create 5 new positions in supporting industries.

Table 5.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from Other Establishments	Chemicals and Selected Chemical Products
Coal mining	$ 5.01
Chemical & fertilizer mineral mining	28.98
Food & kindred products	10.20
Paper & allied products, except containers	9.82
Paperboard containers & boxes	5.85
Chemicals & selected chemical products	194.18
Plastics & synthetic materials	19.81
Drugs, cleaning & toilet preparations	12.48
Petroleum refining & related industries	54.39
Rubber & miscellaneous plastics products	6.91
Primary iron & steel manufacturing	5.64
Primary nonferrous metals manufacturing	14.53
Metal containers	6.93
Special industry machinery & equipment	9.55
Transportation & warehousing	33.55
Electric, gas, water & sanitary services	23.41
Wholesale & retail trade	28.79
Finance & insurance	9.43
Real estate & rental	10.01
Business service	13.03
Gross imports of goods & services	25.93
Business travel, entertainment & gifts	16.14
OTHER INDUSTRIES	69.37
Total Purchases	613.94
Value Added	386.06
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

The production of chlor-alkalies has a substantial attraction for producers of organic chemicals and herbicides. As an example, the availability of chlorine and caustic at McIntosh, Alabama is the main reason for the establishment of a major chemical producer at the same location. As noted in later sections of this report, transportation costs on chlorine and caustic can be substantial and consumers must absorb charges based on the nearest shipping point.

Of significance, many of the locational determinants of organic chemical production closely parallel the chlor-alkali industry. Requirements for the production of titanium metal are similarly close, with heavy reliance placed on waterway transportation of raw materials.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Consumption

Average annual growth in chlorine and caustic soda production has approximated 8.7 percent over the past 5 years. In 1966, production is expected to exceed 7 million pounds. A broad industrial market's base enables the industry to minimize the effects of a change in any one end use. Moreover, major consuming industries such as chemicals, plastics, pulp and paper, aluminum, textiles, soap and detergents are all forecasting record production.

Current chlorine production is now running at close to 95 percent of capacity, and rising consumption has created a general tightening of the supply position, with a concurrent firming in prices. However, the failure of caustic soda markets to keep pace with expected chlorine growth is becoming increasingly problematical as manufacturers expand chlorine capacity. Industry experts are predicting a 7.0 percent annual growth in chlorine consumption and a 5 percent rate in caustic soda demand, during the 5-year period ending in 1970.

Sodium carbonate (soda ash) presents a somewhat different picture. While 70-75 percent of capacity involves synthetic production, modern machinery and transportation systems are allowing natural production in western states to compete effectively in the eastern market. Total consumption will increase during the next 5 years; however, synthetic capacity is expected to remain stable. Further loss of the aluminum market to caustic soda also detracts from the industry's prospects.

Profits

For the overall chemical and allied products industry, profits after taxes approached 8 percent on sales and 14 percent on net worth in 1964. Table 6 reflects profit ratios for the industrial organic and inorganic chemical industries. A review of 1965 data for leading chlor-alkali manufacturers indicates an earnings margin ranging from 5.8-9.4 percent on sales. These industry leaders are all substantially diversified, however, and profits cannot be attributed solely to chlor-alkali production.

Table 6.

Profit ratios in the industrial organic and inorganic chemical industry 1964 1/

	SIC 281 Chemicals, Industrial (64)
Net profits, percent	
On sales	7.40 5.49 3.01
On tangible net worth	14.30 10.66 6.32
On net working capital	37.01 22.66 10.83

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc.

Employment

As can be determined from Table 7, automation has been reducing the number of production workers. This trend started around 1954 and has continued to the present. The high level of new construction together with anticipated future expansion of chlorine and caustic soda capacity will require an upswing in industry employment, although the trend in increased worker productivity will continue.

Table 7.

Employment in the alkalies and chlorine industry 1/

	All Employees (1,000)	Women Employees (1,000)	Production Workers (1,000)	Average Weekly Hours
1958	24.5	-	17.7	39.9
1959	24.2	1.7	17.5	41.2
1960	23.7	1.6	16.9	41.6
1961	22.9	1.6	16.4	41.5
1962	24.0	1.6	17.1	41.8
1963	23.6	1.7	16.9	41.9
1964	23.8	1.7	17.0	41.5
1965	23.0	1.8	16.0	40.9

1/ Source: Employment and Earnings-Establishment Data, Bureau of Labor Statistics

Investment and Locational Activity

The chemical and allied products industry historically has accounted for 10.6 percent of domestic outlays for new manufacturing plant and equipment. This industry is expected to average $2.5 billion annually between 1966 and 1968, increasing to $2.8 billion during the following 3 years. If past relationships hold true, the chlor-alkali segment will invest an average of $72.5 and $81.2 million annually during these periods. However, market researchers of a leading construction firm predict that new chlorine plant investment of over $450 million will be necessary to meet the 1970 U.S. demand.

Table 8 provides a comparison of locational activity of primary chlor-alkali producers in the U.S. and Appalachian Region. Captive production and establishments primarily engaged in the manufacture of other products are not included.

Table 8.

Locational activity for the alkalies and chlorine industry 1/

(Net change)

	Establishments Total U.S.	 Appalachian Region
1963	38	6
1958	34	5
Net increase (decrease).........	4	1
Percent change	11.7	20.0

1/ Source: 1963 and 1958 Census of Manufactures

Intensive expansion of chlor-alkali facilities began in 1965 and has continued through 1966.

Recent developments indicate even greater activity. Expansions by more than a dozen manufacturers are barely keeping up with the growing chlorine demand. No less than 7 major producers have new plants under construction or in the engineering stages. Moreover, not included in this figure are the recently announced programs of 2 of the industry's top producers, both involving additional facilities within Appalachia.

While much of the expanded capacity in past years resulted from modifications to existing equipment allowing increased power input, a major surge in new plant construction is now expected. Significantly, industry concentration appears to be shifting from the large Northeastern salt deposits to the Southeast, Texas gulf, and west coast areas.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Chlorine and caustic soda are coproducts created by electrolysis of a sodium chloride (salt) solution. Brine is decomposed by an electric current, forming chlorine and hydrogen gas at the anode and cathode respectively, and leaving sodium hydroxide (caustic soda) in solution.

Electrolytic cells utilized in the process are of a mercury cathode or diaphragm design. The former entails a higher initial investment, primarily due to the cost of mercury, and has a power requirement roughly 17 percent greater than diaphragm cells. However, it has a significant advantage in producing caustic soda suitable for the rayon industry without further purification.

Over the past 5 years, there has been a general trend toward increased utilization of mercury cells. This process now accounts for 26 percent of capacity and has been growing at the rate of 2 percent annually.

Today, manufacturers are effectively combining the two types of cells. The diaphragm cell produces a dilute solution of salt and caustic. With the addition of fresh salt, it is suitable for feed to a mercury cell, allowing manufacturers to avoid production of impure dilute caustic while minimizing power costs.

The industry does not experience a high amount of equipment obsolescence and some plants date back to the turn of the century. Industry expansion is based on established technology, with manufacturers striving to improve the efficiency of existing processes. Development of the silicone rectifier for converting alternating to direct current with a minimal voltage drop, has resulted in large operating economies and allowed an increase in the capacity of existing equipment.

Raw Materials

The production of a ton of chlorine concurrently provides 2,285 pounds of caustic soda and 57 pounds of hydrogen (10,000 cubic feet).

Primary raw material requirements for electrolytic cell operation break down as follows:

Table 9.

Consumption of raw materials and power 1/

	Requirements per Ton of Chlorine Gas
Electrolysis	
Salt, tons	1.7
Mercury, lb.	0.56
Graphite, lb.	6
HCl, lb.	40
HaOH, lb.	20
Na_2CO_3, lb.	1
Water, gal.	1500-2000
Electricity for lights and motors, kw.-hr., a.c.	50
For electrolysis, kw.-hr., d.c.	
20,000 amp. at 2.04 amp./sq.inch	2900
25,000 amp. at 2.54 amp./sq.inch	3070
30,000 amp. at 3.06 amp./sq.inch	3240

	Requirements per Ton of Liquid Chlorine
Chlorine liquefaction	
H_2SO_4 (98%), lb.	50
Electricity, kw.-hr.	130
Water, gal.	10,000
Steam, lb.	100
Lime, lb.	50

1/ Source: Modern Chemical Processes, Reinhold Publishing Corporation, New York

Manpower Utilization

Productivity in the chlor-alkali industry is partially reflected by the change in value of shipments per employee from \$24,629 in 1958 to \$38,205 in 1965.

Work-force requirements are relatively small. Modern day chlorine plants function with but 4 or 5 operators a shift. Maintenance crews, supervisory staff, and supporting personnel make up the remainder of the plant complement. As with other process industries, the work force is dominated by higher-skilled employees.

Interproduct Competition

The products of this industry are basic chemicals which find their market in a wide range of industries. However, soda ash and caustic soda are interchangeable for about 50 percent of soda ash applications. The failure of caustic demand to keep pace with chlorine production is forcing manufacturers to increasingly invade soda ash markets in order to dispose of by-product caustic. A primary example is provided by the previously mentioned substitution of caustic soda in the production of alumina. This trend is expected to become more pronounced as chlorine producers gear up to meet the anticipated intense demand.

Distribution

Chlorine and caustic soda are distributed primarily through company sales representatives and jobbers. Major consumers are prone to negotiate contractual commitments assuring the availability of adequate supplies.

Outbound shipments rely on rail transportation and usually involve the products in their liquid form. Both products are sold on a freight-equalized basis where consumers absorb charges from the nearest producing point, regardless of shipment origin. Accordingly, locational activity has become more market-oriented as producers become willing to sacrifice higher power and salt costs for overall savings in transportation.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

Locational activity of the chlor-alkali industry will fall in either of the two following categories:

1) Captive or over-the-fence production established by or for one or more prime users to effect maximum supply economies while insuring product availability; or,

2) Commercial production by primary manufacturers designed to serve the merchant market.

Captive production involves a set of locational circumstances which vary greatly with the particular objectives, locations, and requirements of the controlling interests. Accordingly, it is not subject to any consistent locational pattern, and is therefore not treated in this report.

The market orientation of commercial chlor-alkali production serves to prescribe the overall geographic boundaries for new plant locations. Within these limits, the location-seeking executive will strive to optimize operating expenses through the effective balancing of transportation, power, and raw material costs. Site requirements are the remaining primary locational determinant.

Market Orientation and Access

Much of the expanded capacity necessary to meet growing demand will be derived from the addition of facilities at existing locations. New plants will be established at locations allowing economical access to a broad geographical region and will be designed to fulfill specific marketing objectives.

In either event, chlor-alkali markets must be twofold. Economical merchant production involves, as a minimum, plants capable of producing 200 tons per day of chlorine. A plant of this size would concurrently produce 225 tons of caustic and 2 million cubic feet of hydrogen. In order to achieve the marketing balance necessary for efficient operations, manufacturers will frequently extend beyond their effective shipping territory or establish a reduced pricing structure on the surplus commodity, in either case sustaining a reduction in profits.

As noted earlier, chlorine and caustic are sold on the basis of freight equalized from the nearest producing point. By locating on waterways which provide barge access to large areas, producers are minimizing transportation costs and effectively increasing their competitive marketing zone.

Areas most attractive to new plants will exhibit close proximity to a major consuming industry of either basic product, a freight advantage territory (in comparison with existing producing points) which demonstrates potential consumption for the majority of plant output, rail facilities allowing consistent service to major consuming areas, and direct access to barge transportation.

Primary Operating Cost Elements

Within the geographical limitations established by company marketing objectives, manufacturers will attempt to optimize the costs of transportation, power, and salt.

Transportation Considerations

In 1963, almost 70 percent of the industry's outbound shipments moved by rail. While motor carriers accounted for another 18.7 percent, water carriers handled over 8.3 percent. Significantly, about 60 percent of product shipments moved less than 300 miles, and over 75 percent were restricted to a 400 mile radius.

Chlorine and caustic movements require specialized equipment and demand the best in rail service and facilities. Waterway shipments can now utilize 600 ton barges and are becoming an increasingly important means for broadening a plant's marketing territory.

The marketing impact of freight charges is amply demonstrated by measuring these costs against product selling price. Recent quotations revealed the following f.o.b. manufacturer prices, based on a single rail tank car shipment of liquid product:

	Paper Industry (Price per Ton)	All Others (Price per Ton)
Chlorine	$59	$65
50% Caustic soda (rayon grade - dry basis)	$53	$58
73% Caustic soda (rayon grade - dry basis)	$55	$60

These prices can be compared with rail freight charges indicated in Table 10. Significantly, a movement of 350 miles will result in a 23.4 percent increase in the delivered cost of liquid chlorine.

Table 10.

Railroad cost-distance analysis for single car, liquid product movement 1/

Distance (mile)	Cost per Ton (in cents) 2/ Liquid Chlorine	50% Caustic (Dry basis)	73% Caustic (Dry basis)
50	710	820	562
100	890	980	671
150	1030	1140	781
200	1150	1260	863
250	1290	1420	973
300	1380	1500	1028
350	1520	1620	1110

1/ Source: Fantus Area Research, Traffic Department

2/ Notes: (a) Cost per ton is based upon a ton of 2000 pounds.
(b) Costs assume tank car shipment on the following basis:

	Minimum weight (lbs.)	Shipping Weight per dry ton (lbs.)
Chlorine	60,000	-
Caustic	70,000-100,000	50% - 4000 73% - 2740

(c) Rates used to determine costs are published mileage commodity rates applicable within all or part of area under consideration.

A locational analysis of transportation costs must include both inbound and outbound considerations. The large variation in individual plant situations precludes any standard treatment. Volume bulk shipments, competitive pricing of raw materials, and negotiated long-term commitments make this substantial element of plant costs subject to individual analysis.

Power Requirements

The chlor-alkali industry ranks high in power orientation requiring an average of 24.16 kilowatt-hours per dollar value added. Thus, power costs play an extremely important role in determining a plant's overall profitability and give rise to a basic make-or-buy decision. Moreover, power supply interruptions are both costly and hazardous and most all producers maintain emergency generating units.

Operating characteristics of typical mercury and diaphragm cells are as follows:

	Mathieson E-8 Cell (Mercury)	Hooker S-3A Cell (Diaphragm)
Amperes	30,000 amps	24,000 amps
Voltage	4.5 V	3.85 V
Current efficiency	95%	96%
Power consumption per ton of chlorine	3240 kwhr	2760 kwhr

Plants producing 200 tons of chlorine will thus require up to 648,000 kwhr of electricity daily, or an annual demand of over 265 million kilowatt-hours. In general, plants fall into the area of negotiable rate structures and prefer to purchase power. However, manufacturers expanding at a location with an existing power plant will tend to modify these facilities wherever possible. This is encountered in the recent announcement of a leading manufacturer's plans for a $37 million chlorine-caustic-power complex in Lake Charles, Louisiana.

Salt

Production of chlorine and caustic soda accounted for nearly 12 million tons or 39 percent of the total domestic salt output in 1963. Of this, 85 percent was used in the form of brine. In 1963, 6 states accounted for 89 percent of total U.S. salt output, as follows:

	Percent of Total Output
Louisiana	20
Texas	19
New York	16
Michigan	14
Ohio	14
California	6

Smaller quantities can be found in West Virginia, Alabama, and Virginia.

Salt requirements in electrolytic chlor-alkali production run to 3,660 pounds per ton of chlorine. Accordingly, daily consumption for a 200 ton chlorine plant reaches 366 tons and annual requirements will exceed 128,000 tons. Diaphragm cell production can satisfy its raw material requirements with salt purchased as brine, while mercury cell plants will normally purchase the solid product.

The pricing structure for large volume procurement of salt is highly negotiable and usually entails long-term contracts of 3 to 15 years. As might be expected, transportation expenses are a major element in the delivered cost of this primary raw material. However, efforts by some eastern manufacturers to reduce overall raw material expenses have led to increasing utilization of West Indian supply sources.

Comparative economics involved in location determinations require a review of all feasible sources on a delivered basis. Here again, locations removed from local supplies due to marketing considerations will benefit from sites allowing direct access to waterway transportation.

Water Requirements

Typical water requirements for the electrolytic production of chlorine and caustic are reflected in the following table:

Table 11.

Daily water consumption for a 500-ton-per-day chlor-alkali plant 1/

	Gallons
Backwash brine filters	50,000
Dechlorination vacuum pumps	120,000
Deionized water for cells	100,000
Hydrogen cooler	110,000
Total for cell room and brine treatment.	380,000
Chlorine cooling	720,000
Compressors	388,000
Liquefaction	1,300,000
Chilled water unit	130,000
Total for chlorine liquefaction	2,538,000
HCl unit (total)	220,000
GRAND TOTAL	3,138,000

1/ Source: Modern Chemical Processes, Vol 3, Reinhold Publishing Corporation

Most modern plants operate with closed-loop cooling systems which substantially reduce the daily water consumption at the expense of added capital investment.

In general, the industry prefers a water source which is reasonably pure, requiring minimum treatment for process, steam generation, and cooling purposes. Moreover, manufacturers operating on a once-through cooling system have a distinct preference for lower temperature sources. As an example, one producer with a river location utilizes well water in his operations.

Effluent disposal is not generally considered a problem within the industry. Modern day producers will recover commercial elements from main effluent streams prior to discharge. A 97 percent recovery rate on chloride is not uncommon. Plant wastes are alkaline in nature and can be neutralized by the addition of acidic

elements or carbon dioxide in the form of power house stack gas. A relatively simple ponding system is usually all that is required.

Site Requirements

Chlor-alkali plants in the 200 ton per day range will require sites ranging from 80 to 200 acres with access to process water, rail service, and, frequently, waterway transportation. Adequate supplies of ground water would be a distinct advantage as would the existence of high voltage power.

State and Local Tax Climate

New chlor-alkali plants involve an investment of approximately $70,000 per ton per day. Thus, a 200 ton plant will cost about $14 million. Accordingly, firms seeking new locations will avoid, if possible, those areas where machinery and equipment are taxable by local authorities. Communities where local taxes are restricted to assessments on real estate will be most attractive. Tax considerations are somewhat more elastic than previously mentioned locational criteria; however, locales exhibiting a high degree of tax stability will be most suitable for long-term chlor-alkali operations.

Other Locational Determinants

In any locational search, various secondary factors will take on a renewed importance as the final selection process presents communities with similar qualifications. The relative importance of these factors will vary with the individual responsible for the final determination and personal preferences will frequently enter the picture.

Notwithstanding the above, the prudent location-seeking executive will consider labor, community amenities, and the presence of supporting industry of moderate importance. Local legislation and regulations will be of marginal importance and vendor flexibility, lead times, and local police and fire protection will not be of significance in the final selection process.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

The critical nature of power and transportation costs to the profitable operation of chlor-alkali units presents prime areas for effective public investment. Other actions which will increase the attractiveness of the Appalachian Region fall under the general heading of river basin management.

This section of the report emphasizes the extent to which public activity and investment can influence the expansion of the existing industry as well as the pace of future locational activity.

Power

A comparative analysis of power rates in four geographically dispersed Appalachian States indicates a cost range 30 to 70 percent higher than TVA rates for the equivalent demand and consumption. In more absolute terms, this can mean an annual cost advantage approaching $700,000 for the chlor-alkali manufacturer producing 200 tons of chlorine daily. Significantly, this savings would amount to 7.67 percent of the current market value for the plant's total chlorine and caustic soda output.

The above comparison serves to demonstrate the substantial benefit enjoyed by producers located on the TVA system. Public investment and policy oriented toward establishing power rates competitive with TVA will do much for opening new areas of Appalachia to the industry. This program would be most effective when closely coordinated with the development of the inland waterway system.

Transportation

As noted throughout Section IV, transportation considerations play a predominant role in geographic positioning of a new plant, and its overall profitability. Reliance on all forms of transportation is evidenced.

The inherent benefits, and thus, the increasing importance of waterway transportation, demand first consideration. Low cost bulk movements are important for both inbound and outbound shipments. Moreover, the existence of an alternate mode of transportation serves to create the competitive situation necessary for the healthy growth of an industry.

Specific programs already in the planning stage will assist the Region in further development of chlor-alkali production. These are the Warrior-Tombigbee connection with the Tennessee River, and the Alabama-Coosa River extension into lower Appalachia. Fulfillment of these plans as well as the further penetration of other Appalachian areas will open up new locations for the chlor-alkali industry. Of equal importance, the benefits of waterway transportation will accrue also for manufacturers of pulp and paper, chemicals, and titanium, furthering the development of these major consumers and establishing new or larger markets for both chlorine and caustic.

Highway transportation, claiming 18.7 percent of the total 1963 product shipments, presents another opportunity for public investment designed to foster growth of the industry within Appalachia. Completion of the proposed highway corridors will be of substantial assistance; however, the general locational nature of both the industry, itself, and its major consumers requires an emphasis on secondary systems.

The significance of rail is paramount. The industry cannot exist without adequate rail service and location-seeking executives will avoid areas where facilities are lacking, unless firm commitments are readily available.

River Basin Management

While not of overriding significance in the locational equation, river basin management designed to provide flood-free sites, improved water purity, and flow control will serve to improve the competitive position of Appalachia for this industry.

Appendix A

SELECTED INFORMATION SOURCES

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(3) Fantus economic geography files for states and communities.

(4) Manufacturers of chlor-alkalies.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

(7) Industry trade associations.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 10–MATERIALS HANDLING EQUIPMENT

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine, and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically Standard Industrial Classification industry codes 3535, Conveyors and Conveying Equipment; 3536, Hoists, Industrial Cranes, and Monorail Systems; 3537, Industrial Trucks, Tractors, Trailers and Lifts.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the materials handling industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

This study focuses on that portion of the materials handling industry that manufactures conveyors, hoists, overhead cranes, and various types of industrial trucks. Sales of these products in 1966 will produce revenues of about $1.6 billion, or the approximate size of the metal-cutting machine tool industry.

In the U. S., 880 plants employ 56,000 people. This creates an annual payroll of $336 million. Of the 235 plants in the U. S. employing over 50 people, only 11 are located in Appalachia. A concentration of the industry's plants is found in Michigan, Ohio, Illinois, and California.

The industry's prospects for growth are higher than many capital goods industries because of the direct cost reductions available to the buyer. Growth forecasts range from 12-15 percent annually. Sales, profits, employment, and, in turn, plant location activity, should follow this growth pattern.

Many products within the industry are manufactured from purchased subassemblies, which makes the last stages of fabrication relatively routine work suitable for unskilled labor. For example, plants that manufacture floor trucks of various types would find an immediate locational fit in many areas of Appalachia.

The location of branch plants within Appalachia, performing the assembly and shipping function, could presently fit the skills available. On the other hand, the manufacture of cranes, chain hoists, and heavy lift trucks requires skilled machinists in the initial phases of production. While these machinist skills are presently lacking in all parts of the country, there is a marked paucity of them within most of Appalachia.

Market orientation is important to plant location. Appalachian shipping points enjoy lower freight costs to these markets. North Central plant locations that ship bulky products to these same markets have a freight disadvantage.

Public investments that will improve the following location factors are necessary to enhance the competitive position of Appalachia: (1) mechanical labor skills, (2) rail and highway routes, (3) site information retrieval, (4) basic education in the "three R's," (5) sources of finance for small business, and (6) community attractiveness through water and sewage treatment, and added recreational facilities.

I. PROFILE OF THE INDUSTRY

Size

The manufacture of materials handling equipment is a relatively small, but important, part of the industrial machinery group of industries. The value of shipments for conveyors, hoists, cranes, industrial trucks and tractors will be approximately $1.6 billion in 1966, or about the same size as the metal-cutting machine tool business. In 1964 each had sales of $1.3 billion.

The 56,000 employees manufacturing materials handling equipment were paid wages and salaries amounting to $336 million in 1964. Of this amount, $208 million in wages were paid to 35,800 production workers for an annual income per production employee of $5,810.

Table 1.

Rankings of the durable goods industries 1/

(Numbers in millions)

Industry rank	Employment		Value of shipments	
	TOTAL	9.199	TOTAL	$232,170
1	Transportation Equipment	1.624	Transportation Equipment	57,846
2	Machinery 2/	1.537	Primary Metals	40,036
3	Electrical Machinery	1.483	Machinery 2/	34,219
4	Primary Metals	1.179	Electrical Machinery	31,054
5	Fabricated Metals	1.116	Fabricated Metals	24,877
6	Stone, Clay, & Glass	.581	Stone, Clay, & Glass	12,973
7	Lumber & Wood	.562	Lumber & Wood	9,885
8	Furniture	.386	Instruments	6,616
9	Instruments	.309	Furniture	6,302
10	Ordnance	.234	Ordnance	4,421
11	MATERIALS HANDLING EQUIPMENT	.052	MATERIALS HANDLING EQUIPMENT	1,342

Industry rank	Capital expenditures		Value added by manufacture	
	TOTAL	$7,130	TOTAL	$115,744
1	Primary Metals	1,887	Transportation Equipment	23,961
2	Transportation Equipment	1,297	Machinery 2/	19,762
3	Machinery 2/	946	Electrical Machinery	18,039
4	Electrical Machinery	889	Primary Metals	16,732
5	Fabricated Metals	728	Fabricated Metals	12,636
6	Stone, Clay, & Glass	626	Stone, Clay, & Glass	7,520
7	Lumber & Wood	369	Lumber & Wood	4,361
8	Instruments	165	Instruments	4,333
9	Ordnance	117	Furniture	3,225
10	Furniture	106	Ordnance	2,871
11	MATERIALS HANDLING EQUIPMENT	20	MATERIALS HANDLING EQUIPMENT	702

1/ Source: 1964 Annual Survey of Manufactures

2/ Figures for "materials handling equipment" included in "Machinery"

Compared with other industries in this series of studies for the Appalachian Regional Commission, materials handling equipment is relatively small. The value added by manufacture and value of shipments for this particular industry are each one-third that of the textile machinery, pump, and valve group. The materials handling equipment industry is about the same size as the textile machinery industry by itself, and one-twentieth the size of the paper and allied products group.

Products and Markets

Materials handling equipment is used in and around industrial factories, bus, truck, and rail terminals, warehouses, docks, post offices, and other establishments. Bulk handling of raw materials such as grain, sand, coal, ore, and gravel are included. The classification used in this study does not include freight and passenger elevators, moving stairways, mining machinery, construction earthmovers, or transportation on public highways, rail, air, or water.

Table 2 shows the value of shipments for the 3 major product classifications that are subjects of this report, i.e., conveyors, hoists, and industrial trucks.

Table 2.

Industry shipments by production segment 1/

(Percentages based on dollar value)

SIC	Classification	Dollar value of shipments 2/	Shipments % of total
3535	Conveyors	$ 571,542	42.6
3537	Industrial trucks and tractors	532,865	39.7
3536	Hoists, cranes, and monorails	237,661	17.7
	Total:	$ 1,342,068	100.0

1/ Source: 1964 Annual Survey of Manufactures

2/ Represents value of shipments for all products manufactured having standard industrial classification numbers of 3535, 3536, and 3537.

In its efforts to keep manufacturing costs from soaring, U. S. industry has looked to those areas of cost that will provide the greatest savings. Authorities estimate that materials handling costs represent as much as 85 percent of the indirect labor costs in manufacturing, or about 30 percent of the total manufacturing cost.

In many freight handling operations today, the human labor exerted is the same as it was in the time of the trading Phoenicians. For example, a 500-pound bale of cotton is bulled onto a hand truck with one man pushing the bale and one man braking.

Warehouses and terminals for trucking, rail, express, air freight, and parcel delivery are major markets for the industrial lift trucks. Industrial factories use conveyors, hoists, and cranes to run mass production lines and lift heavy machinery and raw stock into position for processing. Lift tables position sheets of metal or wood for cutting or boring operations.

Other products within this industry group include the various types of conveyors. Future use of conveyors will increase at a rate that will maintain its lead in sales for the materials handling group.

Eastern markets for the handling of finished products center on distribution warehouses and terminals at Atlanta, Memphis, Charlotte, Louisville, Chicago, Philadelphia, New Orleans, St. Louis, and New York. Other markets for raw materials handling by conveyor include coal, pulp, mica, clay, cement, and gravel over terrain not economical for truck or rail transportation. Sizable markets exist for raw materials handling equipment at the port cities of New Orleans, Mobile, Savannah, Charleston, New York, Philadelphia, Baltimore, Pittsburgh, and Cleveland.

Plant Ownership and Size Structure

There are 1,199 establishments in the United States manufacturing materials handling equipment. Of these, 887 plants concentrate more than half of their production on conveyors, hoists, cranes, and lift trucks, and only 174 employ more than 50 employees. There are 2 or 3 well-known firms leading each industry. As an example, approximately 80 percent of the industrial lift trucks are manufactured by 3 major companies. Each of these 3 companies is diversified in other product lines that are similar, such as trailers and earthmoving machinery.

Hoists and overhead traveling cranes have two leading stockholder companies that share at least 50 percent of the market. There are approximately 175 other companies producing these products, each with their own specialty and product differentiation. However, there are only 33 plants (with over 50 employees) in the United States that concentrate more than half of their production in hoists and overhead cranes.

Conveyors are led by one company that claims one-fifth of the business, but in general, this sector is fairly well dispersed among 313 manufacturing plants, only 54 of which have over 50 employees.

Geographic Prevalence

The states of Michigan, Ohio, and Illinois, and in general the East North Central States, are geographic centers for production of materials handling equipment in all three product classifications. Of the 174 establishments in the United States with over 50 employees, 71 are in the East North Central States, 29 in the Middle Atlantic States, and 26 in the Pacific States. Table 3 provides a detailed account of prevalence within the United States for establishments concentrating more than half of their production in materials handling equipment.

Table 3.

Materials handling equipment regional distribution of establishments 1/

Geographic area	SIC 3535 Conveyors	SIC 3536 Hoists	SIC 3537 Lift trucks	Total
New England				
Total plants	18	4	10	32
Employing over 50	1	-	3	4
Middle Atlantic				
Total plants	92	20	59	171
Employing over 50	20	4	5	29
South Atlantic				
Total plants	19	1	21	41
Employing over 50	5	-	3	8
East North Central				
Total plants	179	40	98	317
Employing over 50	34	15	22	71
East South Central				
Total plants	18	4	12	34
Employing over 50	8	1	4	13
West North Central				
Total plants	45	7	24	76
Employing over 50	8	2	3	13
West South Central				
Total plants	24	8	16	48
Employing over 50	5	2	3	10
Mountain				
Total plants	10	4	4	18
Employing over 50	-	-	-	-
Pacific				
Total plants	49	32	69	150
Employing over 50	6	9	11	26
UNITED STATES				
TOTAL	454	120	313	887
EMPLOYING OVER 50	87	33	54	174

1/ Source: 1963 Census of Manufactures

There is definitely no sign of Appalachian specialization in this industry to date. It has been common practice for heavy capital goods producers to locate in the vicinity of foundries and large pools of semiskilled labor. The raw material and labor orientation has been changing somewhat in recent years. This subject will be discussed in Section II under "Locational Activity".

Economic Impact

The cost of materials is nearly twice that disbursed for wages and salaries. A comparison of labor and material costs is shown in Table 4.

Table 4.

Comparison of payroll and material costs to value of shipments 1/

($1,000)

Industry	Total payroll	Materials	Value of Shipments
Conveyors	141	231	495
Hoists	64	111	220
Lift trucks	110	215	447
TOTAL	315	557	1,162
Percentage of value of shipments	27%	48%	
Payroll/materials	56%		

1/ Source: 1963 Census of Manufactures

Among the materials purchased, primary iron and steel products share the greatest impact from expenditures. Products manufactured by others in the general industrial machinery and equipment line represent a substantial share of money spent on goods and services. Table 5 displays a breakdown of the industry's gross output in terms of materials, services, and value added by manufacture.

Table 5.

Direct requirements per $1000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from other establishments	Materials handling machinery & equipment
Rubber & miscellaneous plastic products	$ 18.64
Primary iron & steel manufacturing	107.16
Primary nonferrous metals manufacturing	11.53
Heating, plumbing, & structural metal products	11.94
Stampings, screw machine products & bolts	17.30
Other fabricated metal products	20.95
Engines & turbines	13.88
Construction, mining, & oil field	49.16
Materials handling machinery & equipment	40.25
Metalworking machinery & equipment	15.90
General industrial machinery & equipment	66.68
Machine shop products	15.52
Electric industrial equipment & apparatus	48.00
Miscellaneous manufacturing	27.04
Transportation & warehousing	12.26
Wholesale & retail trade	43.06
Business services	14.82
Gross imports of goods & services	11.40
Business travel, entertainment & gifts	12.82
Other industries	75.21
Total purchases	633.52
Value added	366.48
TOTAL	$ 1000.00

1/ Source: September 1965, Survey of Current Business

In 1964, the average weekly earnings for production workers was $119, slightly higher than the $112 for the durable goods industries as a group. The 56,000 employees in the industry, and $336 million in wages and salaries paid in 1964, have had no dynamic impact on the national economy, but they have imparted substantial economic value in those areas where the industry locates. This local impact is evident in the cities of Battle Creek, Michigan; Danville, Illinois; and Philadelphia, Pennsylvania. The wages and salaries paid have the greatest effect on the local economy, despite the fact that a greater portion of expenditures are for materials. Average weekly earnings have been $5-10 higher than the average for the durable goods industry. Most materials are purchased in regions specializing in their manufacture. It is significant that most of the materials purchased by this industry have sources available within Appalachia.

The industry is relatively small and, therefore, has no significant attraction to satellite industries. As a matter of fact, plant statistics indicate that historically this industry has chosen locations that provided access to raw materials. Within Appalachia there are several locations meeting the raw material requirements. However, there are indications that the industry might be tending towards market orientation.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Sales

Historically, the industry has demonstrated industry's recognition of the importance of materials handling in the manufacturing and distributing processes. As mentioned earlier, at least 80 percent of a manufacturing company's indirect costs can be attributed to the lifting, storing, positioning, and stacking of goods in process. A direct step in savings can be attributed to the handling of goods and materials. This savings would cut down on the cost of manufacture, and keep this country's products competitive with those countries having low labor costs.

The annual rate of growth is anticipated to be approximately 12 percent for the next few years. This high rate of growth can be attributed not only to the recognition of the importance of materials handling equipment as a means of cost reduction, but also the fact that federal tax policy has induced heavier than usual expenditures for capital equipment.

Sales have grown in all sectors of this industry since 1961. Overall trends can be demonstrated by Table 6.

Table 6.

Overall trends, 1958, 1963-66 1/ 2/

(Sales in millions of dollars)

Product	1958	1963	1964	1965	1966	Percent change 1964-65	Percent change 1965-66
Conveyors	334	407	436	500	550	15	10
Hoists	166	223	250	295	340	18	15
Lift trucks	277	459	562	650	730	16	12

1/ Source: 1958, 1963, and 1964, Bureau of Census; 1965 and 1966 estimate by Business and Defense Services Administration.

2/ Note: Figures represent the value of products and services sold only by firms primarily engaged in manufacturing products having industrial classification numbers of 3535, 3536, and 3537.

As in almost all sectors of the capital goods industry, back orders are running substantially higher than in past years. Manufacturers have shown intentions of increasing their plant and equipment expenditures in 1967 despite the Federal Government's elimination of the 7 percent tax credit on capital expenditures and imposition of restrictive monetary measures.

Materials handling equipment manufacturers should expect future rates of growth to be higher than they are in many sectors of the capital goods industries because of this industry's relation to spiraling labor costs. As labor costs go up, manufacturers tend to substitute automated machinery for labor. Productivity of metalworking machinery has reached a relative plateau of efficiency whereas materials handling has sizable markets for potential cost reduction.

Profits

Net profits for a representative group of large firms in the industry ran at 5.93 percent of sales, whereas the construction machinery group of industries (SIC 353) as a whole had a median of 4.03 percent in 1964. See table 7 for a comparison of selected firms within the materials handling equipment industry.

Table 7.

Profit ratios for selected companies in the materials handling equipment industry 1/

Company	Net profits percent on sales	Net profits percent on gross property	Net profit per employee
A	4.59	41.96	$ 7,757
B	7.44	N. A.	N. A.
C	5.89	26.95	6,691
D	9.98	46.46	11,722
E	5.26	36.46	6,937
F	2.41	82.98	17,413
Average of selected companies	5.93	46.96	$10,104
Median of construction machinery industry	4.03 2/		

1/ Source: Moody's Industrial Manual, 1966

2/ Source: Dun and Bradstreet, Inc.

Employment

Employment has grown with the demand for the products. Because relatively small portions of the production can be automated as a mass assembly line, no significant reductions have taken place among production workers. In fact, production workers and their average weekly hours of work have increased. (See Table 8.). From 1960 to 1965, the number of production workers increased 20 percent and their average weekly hours of work increased 10 percent.

Evidence to date would support a forecast of an increase of at least 8 percent in employment between 1966 and 1970.

Of the 56,000 employees in this industry group, approximately 5,000, or less than 10 percent, are women. Assembly of predominantly large, heavy parts in manufacturing has precluded female employment gains in this industry.

Table 8.

Employment in the conveyor, crane, lift truck industry 1/

Year	All employees (000's)	Average weekly hours
1958	47.5	39.2
1959	47.5	40.8
1960	47.7	40.5
1961	45.5	41.0
1962	48.6	42.7
1963	50.9	42.8
1964	55.9	42.9
1965	56.0	43.0

1/ Source: Employment and Earnings - Establishment Data
Bureau of Labor Statistics

Production in units produced, rather than dollar value of shipments, provides a reliable benchmark for measurement of employee productivity, and to some extent the degree of automation. Table 9 shows that between 1958 and 1963 production increased 13.4 percent on the average, while production employment increased 6.9 percent.

Table 9.

Productivity as measured by units produced and production workers employed 1/

(Production in thousands of units)

Product	1958	1963
Hand and electric chain hoists	135	168
Wire rope hoists, other than mine and slope	18	23
Air hoists	5	12
Cranes	4	7
Powered trucks and tractors (operator walking)	11	11
Forklift trucks, electric	3	8
Forklift trucks, gasoline	16	28
Total units produced	192	257
Percentage increase in production:		13.4%

(Employment in thousands of production workers)

Industry	1958	1963
Conveyors	12.7	12.6
Hoists, cranes	6.6	6.8
Industrial trucks	9.5	11.4
Total production workers	28.8	30.8
Percentage increase in production workers:		6.9%

1/ Source: 1963 Census of Manufactures, sample from available information.

Automation in production apparently has not made as significant an impact as in the textile machinery, pump and valve industries, for example, where employment decreased 10.4 percent while production increased 30.2 percent in the 1958-1963 period.

Investment and Locational Activity

Estimates from a representative survey of materials handling equipment manufacturers indicate that $89 million was spent in the United States on new plants and equipment between 1958 and 1963. This is a small investment; for example, the construction machinery industry invests that much in just 2 years. As shown in Table 10, this same period saw a net gain of 124 plants in the industry with only 2 in Appalachia.

The 1963 Census of Manufactures shows that Pennsylvania has 18 of the 45 materials handling equipment plants in Appalachia. Location activity in the past few years has centered in California, giving some validity to market rather than materials orientation. Similar market orientation could prove beneficial to Appalachian locations central to several markets. Since 1963, 4 major materials handling equipment manufacturers have announced construction plans within Appalachia, one each in Ohio, Pennsylvania, West Virginia and Tennessee.

Table 10.

Locational activity for selected materials handling equipment industries 1/
(Net change)

Area & industry	Establishments 1958	Establishments 1963	Net increase (decrease)	Percent change
Conveyors SIC 3535				
Total U. S.	420	454	34	8.1
Appalachian total	23	22	(1)	(4.3)
Hoists SIC 3536				
Total U. S.	81	120	39	48.1
Appalachian total	5	6	1	20.0
Lift trucks SIC 3537				
Total U. S.	262	313	51	19.5
Appalachian total	16	17	1	6.3
UNITED STATES TOTAL	763	887	124	16.3
APPALACHIAN TOTAL	44	45	1	2.3

1/ Source: 1958 & 1963 Census of Manufactures.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Much of the manufacturing in the materials handling equipment industry is made to customer specifications which precludes assembly line techniques. Standardized sections for conveyors, small cranes, hoists, and forklift trucks are exceptions where some degree of mass production can be carried on.

Many of the products are assembled from relatively simple component parts. Conveyors, for example, consist of steel frames, rollers, belts, drives, controls, and motors in various combinations. Belts, motors, and controls are generally supplied by outside vendors.

There are some distinct advantages to large-scale plants as illustrated by many well-managed operations in the North Central States. Experience illustrates, however, that selected equipment items may be manufactured in branch plants. For the most part, operations have already been departmentalized in the main plants to achieve economies. These savings can be further enhanced by removal of the simple repetitive operations to lower wage rate locations. Assembly and shipping departments, for example, require lower job skills than the initial tooling and machinery functions. Those departments with the lesser skills would be the most appropriate to move in the initial stages of a plant relocation.

Forklift trucks require heavy forgings and skilled machine work to a greater degree than other products in this industry group. Cranes and hoists also have a great need for skilled machine work. Housings, gears, cams, and shafts for these products are the components requiring skilled machinist work. Assembly of these components by semiskilled, or even unskilled labor is common practice in the industry. Besides machining, heat treating, foundry pattern work, and tool and die work require exceptional skills.

Numerical control machining operations are possible on standard parts that could produce future production economies. With numerical control machinery, punched cards or tapes are programmed by engineers so that boring, grinding, and milling operations can be performed on a preset machine without a skilled operator. Banks of machinery can be supervised by one or two skilled engineers. The machines can be monitored, loaded, and unloaded by semiskilled help. Automation has, in effect, filled a vacuum that has been created by the choice of many entering the labor force to seek white collar work, or forego upgrading their skills in preference for present pay.

However, in the manufacture of conveyors, cranes and lift trucks, unskilled labor represents about 50 percent of the work force. These repetitive operations consist of plate or structural fabrication, stamping, blanking and forming of metals, and assembly of products.

Raw Materials and Materials Handling

The major dimensional stock requirements are steel shapes and castings which are generally shipped by truck or rail under an f.o.b. base point pricing arrangement. Steel shapes are manufactured in Fairless and Bethlehem, Pennsylvania, and Gary, Indiana. Steel castings are produced in Pittsburgh and Chicago. Motors, bearings, controls and other subassemblies are usually shipped in less-than-truckload lots on a hand-to-mouth supply basis. Stocking large inventories of expensive components is costly in terms of space and tied-up capital.

Raw materials inside the more modern plants are handled most efficiently as befitting the purpose of the industry itself. Single story, straight-line plants are common in the production of hoists, forklifts, and small cranes. Subassemblies and parts are brought to the central line by conveyors or forklift trucks carrying tote bins, racks full of parts, or major units by themselves. Using the division of labor principle, unskilled help with some manual dexterity can perform 3 or 4 simple fastening operations and pass the assembly to the next man on the line until the unit is completely assembled.

Manufacturers of conveyors, themselves experts in materials handling, must suffer the consequences of nonstandard conveyor lengths, but for the most part, construct unitized or standard sections that can be attached to nonstandard lengths for completion. Work performed to customer specifications creates job shop techniques in assembly. Production cost estimates do not allow for many assembly errors that are possible on nonstandard production, but less likely on standardized assembly lines where interchangeable parts fit one unit the same as the next. Therefore, a higher proportion of skills are required in the nonstandard production departments.

In these job shop operations, several assemblies take shape in large bay-size rooms within the plant. The assemblies do not move. The workers move around them attaching parts and subassemblies. Similar assembly techniques are used in the large, nonstandard crane and hoist plants. A higher proportion of skilled help is required in the nonstandard assembly operations in order to measure and adjust assemblies to meet job specifications.

Manpower Utilization

In the manufacture of materials handling equipment, experience reveals the following average ratio of job skills:

	Percentage of Work Force	
	Male	Female
Unskilled	38	12
Semiskilled	30	8
Skilled	12	-

Of course, these ratios vary from production of a conveyor assembly to that of a hoist, but not to any great degree.

Subassemblies purchased outside limit the skilled machine work in a conveyor plant, but this skill ratio is offset by the need for higher skills in the nonstandard assembly operations. In contrast, machine shops in standard crane and hoist manufacturing require higher skills, but are offset by lower skill needs in standardized assembly line techniques. Thus, there is a balance of skills, and only department utilization and job requirement vary within the industry.

Product Innovation and Interproduct Competition

Electric eye counters, low-friction bearings, programmed speed controls, interchangeable lifting assemblies for industrial trucks, and even compressed air play important roles in product innovation for the materials handling equipment industry.

Conveyors equipped with electronic eyes or mechanical counters shunt cartons or assemblies into production channels maintaining an even flow within massive assembly operations. Shipping room equipment collects cartons on a revolving pallet table. This table drops one carton height (activated by a weight trigger) for stacking the next level of cartons. The weight trigger causes the loaded pallet to be slipped onto a conveyor where a forklift truck carries the pallet load of stacked cartons to a trailer or rail car.

Floating on air, a ton of materials can be transported across an even floor at the push of a finger. Compressed air directed down to the floor actually reduces friction to zero, and moving heavy loads requires only a minimum effort. Similar friction reduction can be maintained by compressed air conducted up through floor channels of warehouses, trucks, rail cars, and factories.

The conveyors, belts, cranes, hoppers, booms, and the like, are dependent on the basic tool of materials handling--the forklift truck, which lifts and lowers loads up to 12,000 pounds mechanically and with ease. Attachments to forklift trucks can adapt their energy to handling machines, crates, powdered bulk raw materials, timber, oil drums, and even plant maintenance baskets carrying workmen up to ceiling utilities.

Trucks are being turned out with greater lifting ability, higher speeds, increased maneuverability and improved driver comfort and safety. Conveyors and belt linkage are being designed to fit the confines of old plants to make them somewhat more efficient. The ideal factory is designed around the machinery. In the future, this condition will require more coordination between plant engineers and equipment designers, so that the efficiencies of materials handling equipment can be best utilized within unrestricted flow patterns common to new plant construction.

Distribution

The materials handling equipment industry ships its products predominantly by motor carrier for weights less than 30,000 pounds. Rail transportation tends to handle the heavier weights and dimensions exceeding 40' x 90" x 90" (the dimensions of a standard motor carrier trailer). Large cranes, hoists, and partially disassembled conveyor systems move primarily by rail because of their bulk. The greater the distance shipped, the greater the chance that the product will move by rail. Generally, distances more than 600 miles are more dependent on rail service.

2

Because of the close coordination on customer specifications, conveyors and large cranes are usually sold, shipped, and installed directly by employees of the manufacturer. Lift trucks, small overhead cranes and hoists, and standard conveyor units are generally sold through franchised dealers much like the automobile industry. In these latter product lines, factory shipments direct to dealers are usually made upon receipt of the order at the factory. Occasionally a distributorship for a region will receive volume shipments periodically and reship to dealers as orders are placed.

Some of the larger lift truck manufacturers maintain their own regional distribution centers for parts and equipment. Under these arrangements, volume carload or truckload shipments are made regularly, and low parts inventories are filled in as required by less-than-truckload shipments. On occasion, an entire assembly line could be tied up with a parts breakdown in a conveyor or belt, for example. This requires air freight or express service.

Pricing Policy

Traditionally, the industry has been plagued by ruinous price wars. Today, however, its advancing technology is enabling the materials handling industry to concentrate more on improved products than on price-cutting.

Although many products of the industry are sold f.o.b. producing point, competitive conditions and varying trade practices make it necessary to equalize or absorb freight charges in one manner or another. This may entail repricing of some lines while holding to list prices on others.

Diversity of the industry leads to this mixed situation. The pricing problem is most clearly illustrated by considering the marketing pattern of one typical firm. This company produces 34 hand-truck models with 2 wheels, 12 models of platform trucks with 4 wheels, and 5 electric lift trucks with special attachments. All are sold to different types of users; some lines are highly competitive, and others, constitute a virtual monopoly.

Realistic comparison of outbound freight charges from alternate locations must assume that full freight allowances will be reflected in the pricing. There is ample justification for this point. Firms which sell to a national market experience diminishing sales effectiveness as a result of competition in more distant markets from local producers. The local producers have, in effect, penetrated the market by their freight advantage and pricing policy.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Market Orientation

The pricing policy, as just discussed in Section III of this report, is one of the primary locational determinants. Although terms of sale are generally f.o.b. producing point, customary pricing in the industry often requires the manufacturer to absorb a major portion of the freight charges. This freight absorption is costly (up to 12 percent of sales value) to a distant producer.

This factor places much of the industry into a market-oriented position. The manufacturers of bulky products, carrying exceptionally high freight ratings, are most affected by distance from markets. For manufacturers of bulky products, therefore, the market-orientation for a plant is often more important than either labor or materials orientation. After all, if the manufacturer cannot sell his product competitively in the market, he will soon be out of business.

The distant producer, absorbing high freight costs, will look for producing plant locations near the market, particularly where competition from local producers creates price leverage in their favor.

Appalachia has central access to a broad market, as outlined in Section I of this report. Key warehousing, distribution and port cities are major outlets for this type of equipment. Additional industries having a high use factor for this type of equipment include the manufacture of food products, textiles, apparel, primary metals, lumber, and chemicals.

Raw Materials Orientation

Within the constraints of market considerations manufacturers will tend to locate near raw materials. A typical plant with 200 employees will require approximately 2,900 tons of steel shapes and 800 tons of steel castings whose freight cost must be borne by the equipment manufacturer. Other assembly costs for key materials and components are available on a uniform delivered price schedule or may be obtained from local suppliers at competitive prices. As mentioned in Section III, most all of these raw materials and components are produced within the Appalachian Region. (See Section III - Raw Materials.)

Although the materials handling equipment industry has located near raw materials in the past, the transportation penalties of locating as much as 1,000 miles from raw materials can be more than offset by the savings in labor costs or additions to income due to greater market penetration.

Significantly, many of the products are assembled from relatively simple component parts. For this reason, it is economically sound for a manufacturer to be interested in establishment of a branch plant serving the markets on which Appalachia centers. Manufacturers presently operating in the Northeast and North Central States could successfully divert production of those comparatively simple products to a branch plant in Appalachia, in some cases achieving a substantial payroll savings.

Labor Factors

Section III of this report gave details of manufacturing processes and manpower utilization that will support a very strong case for interregional specialization of labor. Many products within this industry group can be made economically only in large, centralized plants having elaborate tooling facilities. One conspicuous exception is the manufacture of floor and platform handling equipment, which includes the following products:

> Utility trucks, tray trucks, platform trucks, shelf trucks, industrial trailers, freight trucks, drag-line trucks, wagon trucks, fork trucks, drum trucks, hydraulic lift trucks, and pallet trucks.

Branch plants housing the assembly and shipping of these products close to the market will require a relatively unskilled work force. Tooling, machining and precision subassemblies manufactured at a plant in the North Central States can be transported unfinished to an Appalachian assembly and shipping plant. If there is only a 10 cents per hour labor cost differential, a branch plant with 200 production workers would save $40,000 annually.

In addition to substantial savings in labor costs, unfinished assemblies knocked-down-flat enjoy lower freight ratings. Class 200 ratings for some setup assemblies have class 85 ratings when shipped knocked-down-flat. Assembled and shipped setup for short distances from branch plants to customers would be a considerable savings over the alternative of shipping setup for long distances.

Also, better machinery performance through quality control checks of setup machines at the factory will substantially reduce guaranteed fulfillment costs. Service and maintenance costs will be cut. Adjustments by field engineers at the customer installation can be a very expensive cost item.

State and Local Financing

All Appalachian states have industrial development financing available either through private firms or revenue bond financing backed by state or local governments. Industrial locations have demonstrated an affinity for revenue bond financing as provided by 8 of the 12 Appalachian states: Ohio, Maryland, Virginia, West Virginia, Georgia, Kentucky, Tennessee, and Alabama.

The major producers of materials handling equipment would have no difficulty in securing favorable bond ratings. The many small firms within this industry might experience some difficulty in revenue bond financial support. Loans from the Small Business Administration help to some degree.

Other Locational Factors

Power, fuel, and water costs are not large enough to result in substantial savings over competitive locations. A 350 kw electric service will supply all lighting and power requirements for a branch plant with 200 employees. Estimated monthly consumption of fuel is based on 10,000 therms or 1,000 MCF (thousand cubic feet) of natural gas. Water consumption for production and sanitation should not exceed 880,000 gallons per month.

Site requirements fitting the needs of materials handling branch plants would involve a minimum of 15 acres of land suitable for improvement. Rail service adjacent to the site would improve the locational attraction.

The importance of living conditions for employees appears to become more apparent as the proportion of white collar and plant administration personnel increases. Early stages of branch plants might not require the relative sophistication of community choice; however, those locating with longrun prospects of establishing a major facility or a home office would place great emphasis on the services and community amenities provided its personnel.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

Many products in the materials handling equipment field could be manufactured within Appalachia today without additional improvement of labor skills, highways, railroads, or financing capacity. However, steps to improve these location factors will definitely increase the competitive position of Appalachia over many areas of the country.

Priorities of action should be arranged as follows:

1) improve mechanical labor skills through rural regional vocational training schools;
2) improve transportation corridors;
3) upgrade basic education through long-range programs;
4) catalog at a state and local level suitable sites along abandoned trackage with a potential for improvement;
5) raise the limits of loans and loan guarantees under federal programs;
6) improve community attractiveness and living conditions including school and medical facilities, water and sewage treatment, and regional recreational facilities.

Vocational Training

Locational activity in the materials handling equipment industry is restricted to areas where the required skills are available. In some cases, only those departments or product lines requiring very limited skills could move into many sectors of Appalachia. Upgrading the mechanical skills of the labor force within Appalachia would enhance locational activity.

Vocational training courses that will furnish a higher skilled labor force for the materials handling industry include: tool and gauge measurement, mathematics up through simple algebra, basic machine operations, safety and attitudes, numerical control programming, blueprint reading, drafting, production-line technique, welding, brazing, heat treating, steel foundry principles, foundry pattern work, and tool and die making. Many of these courses require a basic mathematics background that would limit the number of candidates for a training program.

Initial efforts to train those now capable is important. A greater number will be prepared for technical courses in the higher skill requirements as basic education standards are raised, as students are attracted to staying in school in preference to dropping out, and as funds can be provided to inculcate the slow or indifferent by special attention and recycling through basic reading, writing and mathematics.

For instance, industry's future needs for programmers in the numerical control of machines will grow at a rate faster than supply. Shortages in machine programmers could very well inhibit the growth of the manufacturing industries in the same way that the electronic data processing field is presently experiencing shortages.

Vocational training courses in many areas today reflect the needs of industry yesterday. Training departments in high schools have, in many cases, become the dumping grounds for those failing in academic pursuits.

To date, recommendations, programs and funds have been at arm's length from the problem. Industrial management knows what the problem is better than the educators do. The plant superintendent feels the impact of unskilled labor to an even greater degree. His performance is measured by the productivity, and thus the skills, within his plant.

It is recommended that the responsibility for training be placed with those individuals who will hire the trained help in order to insure that the needs of industry are met. Industrial apprenticeship programs sponsored and guided by industry, and training directly for industry's needs, will be more responsive to technological change and skill requirements.

As an example of the above, several personnel managers and tool shop owners in a major eastern city were questioned on the effectiveness of the Federal Manpower Training Act of 1961 in their line of work. Two of the seven interviewed had no idea what the purpose of the Act was; four had some idea of the Act's provisions; and only one, a tool job shop owner employing 85 people, had taken advantage of the Act's provisions. Industry apparently has not adopted, nor cared to adopt, programs which are not of its own design. Let them write the program, however, and they will, in effect, underwrite it.

Apprenticeship goes back to the trades of the Middle Ages. Skilled crafts did not really grow until the Industrial Revolution. At the turn of the century, a major tool manufacturer in New England was graduating between 50 and 150 four-year apprentices each year. These apprentices paid for the opportunity of training. Today you cannot give the training courses away. The apprenticeship program slowly died after World War II. Young men chose white collar work over blue collar work, immediate pay envelopes rather than deferred pay at higher levels, and less skill with cleaner hands in preference to more skill and unclean hands.

Federal Government tax incentives to those firms investing in training skilled help would encourage industry's assistance. Tax credits of 7 percent and accelerated depreciation allowances have been instrumental in encouraging investment in new machinery. In a similar manner, tax credits could encourage investments in training a skilled labor pool that would not only affect Appalachia, but would have a long-range and diffuse effect throughout the country. National defense manpower policy, for example, would be actively promoted by these training programs that upgrade mechanical labor skills.

The benefit of training does not necessarily remain with the company that provides the program. Therefore, the tax credit is not discriminating by assisting a privileged group. Apprenticeship and management trainee programs have a history of some benefit to the company giving the training, but turnover due to slightly higher pay incentives will attract trainees into other firms. In this way, the benefit of training is widespread.

On-the-job training programs to complement the vocational training in schools will place the worker directly into a factory atmosphere. Initial stages of plant location generally anticipate on-the-job training which may take up to 3 years to perfect. Screening the work force will glean those with mechanical aptitudes. First class machine operators may not be developed for 3 years, but industry has demonstrated its willingness and patience to train those showing ability.

As mentioned in Section III, and earlier in this section, the primary location activity likely for Appalachia will consist of assembly and shipping departments that will form a nucleus for further expansion of the branch plant function as mechanical skills are made available.

Improved Transportation Corridors

The materials handling industry requires access to raw materials by rail and access to markets by highway. To provide more direct access to raw materials and to markets, the present system of highways and railroads must be replenished, rebuilt, and extended. Both highways and railroads in many rural areas have need for entirely new beds, routes and grades.

In particular, rail lines to abandoned coal mines have been overgrown with brush and themselves abandoned. Many miles of these lead tracks pass exceptional plant sites that would fit the 15-to 20-acre requirements for branch plants of materials handling manufacturers. (See the next subject, "Industrial Sites.")

North-south rail lines need to be encouraged by tax concessions and grants that will further generate private investment. This will, in effect, enhance the supply of basic steel castings and forgings from the producing areas of Birmingham and Pittsburgh.

East-west highway corridors to encourage plant locations for this industry should be routed from southeastern Kentucky to northwestern North Carolina; and from the area of Roanoke, Virginia to Berkeley, West Virginia; and also from the Cincinnati, Ohio area east to the area of Clarksburg, West Virginia.

Program assisting feeder airline passenger service would promote this industry's growth in Appalachia. Customer service and installation liaison is important to the marketing of many products in the materials handling line.

Waterway transportation would not benefit this industry's needs to the extent that public investment would stimulate its location activity or growth.

Industrial Sites

As mentioned in the transportation section, many sites along abandoned rail spurs fit the needs of this industry. The problem is to identify these sites. State, local and railroad development agencies should catalog these sites by size, location, mileage from main rail line, and utility services available or abutting the property. Approximate costs of gaining access to each site would establish priorities of selection.

Financing

Availability of financial assistance will be of varying importance to different companies of the industry. Revenue bond financing would be most attractive to larger, integrated operations. Local subscription may suffice for simple assembly plants. In all cases, the community must be responsive to the needs of the industry and prepared to provide prompt commitments for supplying requisite utilities and services.

Other Areas of Public Investment

Lower power costs would not substantially enhance the location activity for this industry group. Each year the materials handling industry consumes about 4,500 kilowatt-hours per employee, or about one-half a kilowatt-hour per dollar value added in product manufacture.

Efforts to improve community attractiveness will be decidedly important as the location screening process produces 2 or 3 finalists. Adequate school systems and medical facilities are a necessity. Community services and recreational facilities will also be important.

Appendix A

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(3) Fantus economic geography files for states and communities.

(4) Manufacturers of materials handling equipment inside and outside Appalachia.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 11--THE MOBILE HOME AND SPECIAL PURPOSE VEHICLE INDUSTRIES

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically Standard Industrial Classification industry codes 3791, Trailer Coaches; and 3713, Truck, Bus, and other Vehicle Bodies.

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

For the purposes of this study, special purpose vehicles have been defined as that segment of truck and bus body manufacture limited to "complete vehicles produced on a purchased chassis." Accordingly, the industry is characterized by a multitude of small, urban-oriented producers accounting for only 16 percent of the shipments originating in the truck and bus body industry. Nonetheless, locational factors parallel the trailer coach industry and vary only in degree.

Trailer coach production involved 1964 shipments of $930 million or 11.4 times greater than special purpose vehicles. Trailer coach employment in that year exceeded 32,500 with production reaching 281,690 units. The current ratio of mobile home production to "new housing starts" approximates 1-to-5.

In 1965, no less than 220 firms were producing trailer coaches in 354 United States plants, and 6 publicly held firms controlled over 30 percent of the market. Marketing considerations are leading a trend of acquisitions and mergers, expected to continue into future years. Presently, 62 percent of the production is concentrated in the 5 states of California, Georgia, Kansas, Indiana, and Michigan, although Appalachia claims a respectable representation.

The industry's growth outlook is excellent; leading industry experts predict a 100 percent increase in sales by 1970. Profits remain relatively low due to a competitive pricing structure and are lending impetus to the trend of merger activity.

Prospects for new locational activity are equally good. Efforts to minimize costs are attracting new activity with a degree of market orientation heretofore unknown. This is occurring in the midst of a trend to larger units which is limiting capacity of existing production facilities at a time when demand is growing.

Market orientation prescribes the basis for new locations. Within this framework, manufacturers will strive for locations providing minimum total operating costs. Highways and rail service are important considerations, and labor must demonstrate good productivity, moderate wage patterns, and should be free from undue wage pressures. Site requirements are easily satisfied with 5 to 20 acres of general-purpose industrial real estate.

Opportunities for public investment or actions are unique. While some areas involve general development commonly beneficial to many industries, i.e., highway, rail, and vocational training, Appalachia is in a position to create an internal market of substantial significance. Geographically, Appalachian locations can serve close to 50 percent of the total market.

Public investment, policies, and activities can be directed to developing the internal market, and thus attracting new plants by fostering the controlled growth of new mobile homesites, eliminating antiquated community restrictions and regulations, utilizing mobile home subdevelopments for public housing projects, and providing more realistic financial terms of purchase. The opening of new recreational areas for travel trailers and campers will further benefit the industry.

I. PROFILE OF THE INDUSTRY

Size

On an overall basis, the transportation equipment industry ranks first in terms of employment and value added and second in new capital expenditures, in a 1964 comparison with all durable goods industries (see Table 1). The production of trailer coaches (mobile homes, SIC 3791) and truck and bus bodies (SIC 3713) accounted for roughly 3.6 percent of the total industry (SIC 37) employment, 2.2 percent of the value added by manufacture, and 1.5 percent of the industry's new capital expenditures.

Table 1.

Rankings of the durable goods industries, 1964 1/

(Numbers in millions)

Industry rank	Employment		Value added by manufacture		Capital expenditures	
1	TRANSPORTATION EQUIPMENT	1.62	TRANSPORTATION EQUIPMENT	$23,961	Primary metals	$1,887
2	Machinery	1.54	Machinery	19,762	TRANSPORTATION EQUIPMENT	1,297
3	Electrical machinery	1.48	Electrical machinery	18,039	Machinery	946
4	Primary metals	1.18	Primary metals	16,732	Electrical machinery	889
5	Fabricated metals	1.12	Fabricated metals	12,636	Fabricated metals	728
6	Stone/clay/glass	.58	Stone/clay/glass	7,520	Stone/clay/glass	626
7	Lumber/wood	.56	Lumber/wood	4,361	Lumber/wood	369
8	Furniture	.39	Instruments	4,333	Instruments	165
9	Instruments	.31	Furniture	3,225	Ordnance	117
10	Ordnance	.23	Ordnance	2,871	Furniture	106
	TRAILER COACHES, TRUCK AND BUS BODIES	.06	TRAILER COACHES, TRUCK AND BUS BODIES	530	TRAILER COACHES, TRUCK AND BUS BODIES	20

1/ Source: 1964 Annual Survey of Manufactures, U. S. Department of Commerce.

In 1964, employment involved in the manufacture of mobile homes equaled 32,686, while truck and bus body production provided employment for another 25,944. Combined shipments for these industries amounted to over $1.4 billion in 1964, as measured by the Annual Survey of Manufactures.

Producers of special purpose vehicles fall into that category of truck and bus body manufacture (SIC 3713) limited to "complete vehicles produced on purchased chassis." These include ambulances, hearses and other undertakers' vehicles, military and commercial buses, trucks, etc., which in total, comprise just over 16 percent of the shipments originating in the truck and bus body industry.

Products and Markets

The relative significance of the 2 industries discussed in this report is reflected by 1964 value of shipments, measured by the U. S. Department of Commerce:

	Value of 1964 Shipments ($ million)
Mobile homes	$ 929.8
Special purpose vehicles ...	81.6
Total	$1,011.4

Two distinct product lines have been gradually introduced by the trailer coach industry. Travel trailers, designed for vacationers, are small and light, weigh less than 4,500 pounds, and are under 29 feet in length. Mobile homes, serving a market of relatively stationary permanent dwellers, exceed travel trailers in size and luxury. While both have the common element of chassis-mounted mobility, they serve 2 different and separately expanding markets. Travel trailers accounted for 33.1 percent or 107,580 of the 324,050 units produced in 1965. To emphasize the distinct nature of the markets, over 20 percent of the travel trailer owners also own a more permanent mobile home.

Nationally, mobile homes account for one-third of all housing under $10,000, and provide shelter for 1.25 million families or nearly 4 million people (over 2 percent of the population). Since 1960, they have accounted for about 7 percent of the total dwelling units constructed. In 1965 a new mobile home was completed for every 5 constructed on a solid foundation.

The advantages of mobile homes are especially attractive to young married couples and senior citizens--2 segments of the population growing faster than the total. Purchase prices run substantially lower than comparable conventional homes and include all furniture and fixtures. Moreover, there are large savings in upkeep.

Contributing greatly to the recent growth in mobile home sales has been the changing image of the trailer park and dweller. Formerly associated with the migrant worker, the influx of new consumers in search of lower housing expenditures has combined with changes in zoning restrictions and the development of "planned" communities to enhance the respectability of mobile home living. This is amply demonstrated by statistics on the current distribution of mobile home owners by occupation:

	Percent of Total
Skilled and semiskilled labor ..	47
Retired and semiretired	22
Farmers, clerical, sales and service	13
Professional and managerial	10
Military	8
Total	100

Retail sales for all trailer coaches ran to over $1.2 billion in 1965. Around $225 million is attributed to travel trailers.

Based on the industry retaining a 5-to-1 ratio of production versus new housing starts, the 18-state market area competitively served by the Appalachian Region will account for over 47 percent of the mobile home purchases. Conservative projections for a 10 percent growth in 1966 unit sales would indicate an area requirement for over 113,000 units, broken down in the following table.

Table 2.

Breakdown of mobile home market
competitively served by Appalachian locations 1/

State	Percent of Total
Alabama	2.6
Connecticut	4.2
Delaware	.9
Florida	12.8
Georgia	5.6
Kentucky	2.7
Maryland	9.8
Massachusetts	5.1
Mississippi	.9
New Jersey	8.6
New York	14.2
North Carolina	3.0
Ohio	9.4
Pennsylvania	6.2
South Carolina	.9
Tennessee	3.7
Virginia	9.2
West Virginia	.2
Total	100.0

1/ Source: Adapted from Construction Review, U. S. Department of Commerce, July 1966

The travel trailer market is more dependent on personal income and population. Significantly, this same 18-state area claims over 48 percent of the nation's effective buying income.

Special purpose vehicle markets are more related to the degree of urbanization and commercial activity within a given area.

Plant Ownership and Size Structure

The tabulation presented in Table 3 reflects the overall size structure of the industry, as measured by latest census statistics.

Table 3.

Total industry by employment groups 1/

		No of Plants with Employment of					
	All Plants	1-19	20-49	50-99	100-249	250-499	500 or more
Truck and Bus Bodies (SIC 3713)	609	402	119	44	22	14	8
Trailer Coaches (SIC 3791)	413	161	87	77	75	12	1
Total	1,022	563	206	121	97	26	9

1/ Source: 1963 Census of Manufactures

Most mobile home and special purpose vehicle manufacturers are privately owned, including many of the industry's leaders. In 1965, there were 220 firms producing mobile homes in 354 U.S. plants, with 6 publicly held companies controlling over 30 percent of the market. Efforts to expand marketing territories and augment product lines have led to a continuing trend of acquisitions and mergers. Roughly 50 percent of the plants specialize in manufacturing mobile homes. Most of the balance produce travel trailers with less than 50 establishments making both products.

Mobile home plant capacities vary from 1 or 2 units per week up to 40 units per day. Plants employing 100 workers would ship between 800 and 900 units annually. A school bus plant with 100 employees would produce around 550 units a year.

Geographic Prevalence

State representation in trailer coach and special purpose vehicle manufacture is summarized as follows:

	Number of states with industry representation	Number of states with more than 10 establishments
Trailer Coaches (SIC 3791)	38	10
Special Purpose Vehicles (SIC 3713)	41	22

While 37 states claim representatives of the mobile homes industry, about 62 percent of the production is found in the 5 states of California, Georgia, Kansas, Indiana, and Michigan. Similarly, 45 percent of travel trailer output is controlled by Illinois, Indiana, Michigan, Ohio, and Wisconsin. Table 4 presents the actual distribution of establishments among the census districts.

Table 4.

Regional distribution of establishments, special purpose vehicles & mobile homes 1/

Area	Special Purpose Vehicles (SIC 3713)	Trailer Coaches (SIC 3791)	Total
New England			
Total plants	33	5	38
Employing over 50	1	-	1
Middle Atlantic			
Total plants	119	24	143
Employing over 50	17	11	28
South Atlantic			
Total plants	119	45	164
Employing over 50	33	24	57
East North Central			
Total plants	77	129	206
Employing over 50	8	46	54
East South Central			
Total plants	69	7	76
Employing over 50	11	6	17
West North Central			
Total plants	35	33	68
Employing over 50	2	16	18
West South Central			
Total plants	39	42	81
Employing over 50	5	16	21
Pacific & Mountain			
Total plants	118	128	246
Employing over 50	11	46	57

1/ Source: 1963 Census of Manufactures

Appalachian Specialization

Table 5 demonstrates a degree of specialization which compares favorably with the area's population. However, production concentrations in the Alabama, Georgia, and Ohio fringes of Appalachia speak well for the potential of the region.

Table 5.

Establishments within the Appalachian region 1/

State	Trailer Coaches Total	Trailer Coaches Employ over 50	Truck and Bus Bodies Total	Truck and Bus Bodies Employ over 50
New York	-	-	3	1
Pennsylvania	24	14	23	3
Maryland	-	-	-	-
Virginia	-	-	1	-
West Virginia	-	-	1	-
Ohio	1	1	1	-
North Carolina	-	-	1	-
South Carolina	1	1	1	-
Georgia	2	1	-	-
Kentucky	1	1	4	-
Tennessee	2	2	2	-
Alabama	6	6	6	-
Total	36	25	43	4
Percent of U.S. establishments	8.7	15.2	7.1	4.5

1/ Source: 1963 Census of Manufactures, updated by Fantus Area Research Files

Economic Impact

The economic impact of these industries is not readily measurable by either the U. S. National Income and Product Accounts or the interindustry (input-output) tables. However, the impact of a new plant on a given area can be partially assessed through application of an "economic velocity" factor to the annual value of the new manufacturing employment.

Typical new trailer coach establishments employ an average of 150 workers. Using the industrywide average wage, such a plant would disburse annual wage and salary payments approaching $750,000. Conservative estimates of economic velocity convert this to a total impact of $2.25 million. Similarly, a new special purpose vehicle establishment employing 75 workers would create an annual payroll of $446,000 with a total impact of $1.34 million.

Primarily, these industries are both of an assembly and fabrication nature. There is a tendency to maximize local purchases avoiding high shipping costs of inbound materials. Thus, the area boasting a new establishment will further experience the indirect impact from increased business activity of local suppliers. Among the major requirements are lumber, plywood, aluminum, steel, carpeting, furniture and furnishings.

The corollary to the above is the attraction the industry exhibits for new development of supplying industries within the locale. Experience around Kansas manufacturing concentrations demonstrates the locational pull for fabricators of cabinet assemblies, fixtures, and other component assemblies.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Sales

Retail sales in the trailer coach industry reached new heights in 1965 for the fourth straight year. A 13 percent increase over 1964 provided revenues in excess of $1.2 billion and the Mobile Homes Manufacturers Association predicts another 10 to 15 percent rise in 1966. The past 10 years of unprecedented growth has been primarily due to: (1) mass production economies allowing for fully-equipped housing at two-thirds the cost of comparable permanent dwellings; (2) construction of dual-laned highways; and (3) the changing image of mobile home living. Table 6 reflects the industry's growth during the past 5 years.

Table 6.

Manufacturers' shipments of
mobile homes and travel trailers 1/

	No. of units		
	Mobile homes	Travel trailers	Total
1961	90,200	40,500	130,700
1962	118,000	57,000	175,000
1963	150,840	72,170	223,010
1964	191,320	90,370	281,690
1965	216,470	107,580	324,050

1/ Source: Construction Review, U. S. Department of Commerce, July 1966

Today the average mobile home sells for $5,600, as against a $17,000 average for new permanent single-family dwellings. Significantly, the year 1964 saw mobile homes sales up 24 percent while 1-family housing starts experienced a 4 percent decline. The trend can be further emphasized by the following:

	Mobile homes as a percent of housing starts (Total units)
1961	9.3
1962	10.8
1963	12.6
1964	16.9
1965	20.1

Travel trailers have exhibited a comparable growth. Unit production in 1965 was more than 6 times the 1956 total. Rising personal income, increased leisure time, and the opening of recreational parks to travel trailers speak well for the future of the industry.

Perhaps the most significant development for the industry has been the boom in popularity of the truck-mounted camper. The sales and consumer research department of a leading automotive manufacturer estimates the 1966 market at 100,000 units. Moreover, their studies show that nearly 1 out of 6 buyers of light-duty trucks intend to install a camper body, and that 1 out of 4 purchasers are buying a truck for the first time. Further consumer research demonstrates that 60 to 65 percent of tent owners will be buying-up to truck campers. All of the above factors have combined to create a projected requirement for 800,000 units over the next 4 years.

Other industry experts have predicted the following growth rates for the 5-year period ending in 1970:

	Percent of Increase
Mobile homes	100
Travel trailers	100
Travel trailers and campers (combined)	189

While the production of special purpose vehicles is predominantly spread among many smaller manufacturers, the largest producer of mobile homes operates separate divisions for truck, bus, ambulance and funeral car fabrication. These markets are all expected to grow with the increasing population, urbanization, and greater emphasis on education.

Profits

Competition among those in the trailer coach industry has led to a relatively high degree of price stability over the past decade. Contrary to the housing industry, most manufacturers are making money without raising prices. However, profit ratios remained consistently below the all manufacturing level of 5.7 percent in 1965, as witnessed by returns of 2.51 to 3.51 percent experienced by 3 of the industry's leading publicly-held corporations. Table 7 reflects a similar situation for producers of auto, bus, and truck bodies, although it is estimated that these ratios are somewhat higher for small manufacturers of special purpose vehicles.

Table 7.

Profit ratios in the mobile homes and special purpose vehicles industry 1964 1/

	SIC 3712, 3713 Bodies, auto, bus & truck (36)
Net profits, percent	
On sales	3.11 1.67 .63
On tangible net worth	12.11 7.28 1.92
On net working capital	17.05 10.80 3.12

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc.

Continued acquisition and merger activity, and the establishment of new plants with higher productivity and minimum operating costs are expected to boost the industry's efforts for increasing profit margins.

Employment

Trailer coach industry employment is reflected in Table 8. In the 6 years between 1958 and 1964, the industry underwent a 75 percent increase in total employment with fully one-half of this occurring in 1964. While a certain amount of distortion is inherent in the comparison due to the differing collection procedures for the two data sources, an independent verification procedure has shown the figures to be quite accurate.

Table 8.

Employment in the trailer coach industry (SIC 3791) 1/

Year	All employees (1,000)	Production workers (1,000)	Average weekly hrs. (Production workers)
1958	18.7	16.0	38.3
1959	21.4	18.1	38.6
1960	22.3	18.6	36.8
1961	20.7	17.5	34.2
1962	21.0	17.9	34.9
1963	25.7	21.9	36.2
1964 2/	32.7	27.6	43.4

1/ Source: 1963 Census of Manufactures

2/ Source: Annual Survey of Manufactures, 1964

Of interest, the production of trailer coaches is rather labor intensive with 85 percent of the work force comprised of production employees, and little opportunity for full-scale automation. Accordingly, productivity has remained relatively stable since 1962. Thus, assuming the condition will continue, production requirements for the 1970 market will call for a doubling of the work force.

Employment involved in the manufacture of special purpose vehicles, as defined in this report, is difficult to estimate. Nonetheless, labor characteristics parallel the trailer coach industry and increasing demand will cause a proportionate rise in employment.

Locational Activity

During the period from 1958 to 1963, the trailer coach industry experienced a 7 percent increase in establishments throughout the U.S. Growth of the industry within Appalachia was substantially more dramatic, as noted in the following table.

Table 9.

Locational activity for
the trailer coach industry 1/

(Net change)

Industry	Establishments 1958	Establishments 1963	Net increase (decrease)	Percent change
Trailer Coach Industry				
Total U.S.	386	413	27	7.0
Appalachian Region	16	22	6	37.5

1/ Source: 1958 & 1963 Census of Manufactures

The trend of mobile home locational activity to Appalachia has become even more pronounced since 1963. No less than 14 new plants and 4 expansions were established or announced during this period. While Pennsylvania and Alabama claimed the major share of this activity, Tennessee, South Carolina, Georgia, and Ohio all increased their representation of the industry.

The mobile home market shift to larger sized units has provided an added impetus to the industry's locational activity. One of the industry's leaders recently was forced to expand manufacturing space by 15 percent with no increase in capacity. Meanwhile, another top firm added 7 new or acquired plants in 1965 to bolster its efforts for increased capacity.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

The technology of mobile home and travel trailer manufacturing closely parallels that of more permanent home construction. Countless numbers of different models produced by the many firms in the industry vary little in manufacturing technique. The overall weight of the unit gives a rough measure of the amount of materials used in construction. Higher priced units are heavier by 20-30 percent with more and larger windows, more framing pieces, better workmanship in finishing, heavier and stronger materials throughout.

In essence, the major difference from permanent home construction lies in the standardization of models and a heavier reliance on purchased, unitized fixtures. Both the small and the large producer will attempt to utilize production line techniques to the maximum extent possible. However, the need to conform with established building codes retains a certain element of craftsmanship.

As the industry trends to larger plants, increased prefabrication and application of assembly line techniques can be expected.

The production of special purpose vehicles differs in both materials and skills, although here again, the size of a plant limits its degree of automation. Practically speaking, most establishments are custom-shops mounting bodies on customer-specified, purchased vehicles.

Larger manufacturers, with plants specializing in certain types of vehicles, are afforded some of the economies of mass-production techniques. Thus, producers of school buses, ambulances, or funeral cars can benefit somewhat from Detroit-style automation, but still rely heavily on craftsmanlike techniques involving portable welding equipment.

Raw Materials

The principal raw materials used in the manufacture of trailer coaches include lumber, plywood, masonite, aluminum sheet and siding, steel shapes, insulation, wheel assemblies, furniture, appliances, and fixtures. Special purpose vehicle manufacture requires engine and chassis assemblies, steel (some galvanized) shapes and sheets, hydraulic, signaling and lighting units, and in some cases, lumber, insulation and upholstery materials.

Manpower Utilization

As noted earlier in this report, about 85 percent of the work force is made up of production employees. Female requirements are minimal.

In general, the element of craftsmanship common to both industries precludes dramatic changes in productivity. Nonetheless, as new and larger plants come into being, the impact of increased opportunities for manufacturing efficiencies will be noticeable.

Of interest, the following represents the trailer coach unit output per production employee during recent years:

	Units per production worker
1961	6.31
1962	8.33
1963	8.67
1964	8.61

Distribution

Trailer coaches are sold primarily through dealerships located in urban areas throughout the U.S. Many of these are financed by the manufacturer. The industry's leader utilizes some 1,500 dealers to market the products made in 17 plants.

Freight from a manufacturing plant to the point of sale approaches 40 cents per mile for mobile homes, and thus, plants located near the major markets have a competitive edge with the price-conscious consumer. Mobile homes depreciate about 50 percent the first year and 10 percent yearly thereafter. About 75-80 percent of the mobile homes sold through dealers are financed with terms of 15-25 percent down and the balance spread over 7 or 8 years. Some manufacturers are facilitating the consumer with the establishment of financing subsidiaries. The average customer keeps his home about 3 years and while trade-ins are increasing, they have not yet become an important element in the industry.

School buses are sold largely through competitive bidding while most other special purpose vehicle producers directly serve a local market.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

The major factor involved in locating a mobile home plant is proximity to the market. Thus, outbound freight costs are minimized while dealer liaison is greatly facilitated. Secondary factors, while not so inflexible, also carry considerable weight in the location equation. These include both transportation considerations and labor force characteristics.

Within a given market, manufacturers will look for locations providing minimum total operating costs. For larger branch plant operations, an attractive community environment will prove a definite asset.

Special purpose vehicle manufacturing differs from the above only in degree; that is, marketing considerations will be much more geographically limiting.

It is the purpose of this section to evaluate the relative importance of primary locational determinants as they operate in the commercial marketplace.

Market Orientation and Access

The increasing cost of delivery to the sales point has forced the industry to decentralize and locate branch service and assembly plants near potential markets. Trends to larger and heavier units emphasize the importance of this primary locational consideration.

In establishing new locations, the criteria applied usually requires a market for 90 percent of the plant output, within a 250-mile radius. Assuming an adequate highway network,this area would fall within one-day service distance of the shipping point.

The economical aspects of mobile home living, where the benefits of low purchase and maintenance costs are further enhanced by the inclusion of new modern furnishings, would indicate a substantial market potential within Appalachia itself. Moreover, Section I of this report demonstrates that close to one-half of the total potential market is accessible to Appalachian locations. A similar amount of the nation's total effective buying income is located in the same area, indicating a prime target for travel trailer producers.

From a marketing standpoint, the extreme Northern and Southern States of Appalachia might appear most attractive. This is witnessed by the fact that 7 new plants located in Pennsylvania and 4 in Alabama since the beginning of 1964. Not to be forgotten, however, are the population concentrations along the middle Atlantic coast and the rapidly rising purchasing power found in Kentucky and the Carolinas.

Transportation Considerations

Various aspects of transportation facilities, service, and access will combine to determine a location's suitability for servicing a specified market.

Of paramount importance is the existence of a comprehensive 4-lane and/or limited access highway system. The cost of moving a completed mobile home runs to 40 cents per mile. Moreover, the trend to larger sized units is placing increased limitations on the industry's shipments, with restrictions that frequently cover both road usage and movement timing.

Delivery cost calculations demonstrate the significance of the transportation element in the location equation. Southern purchasers of a mobile home shipped from the Great Lakes area can be faced with shipping charges of over $300. This amount is equal to a 5 percent price increase to the economy-minded consumer.

Highway considerations in travel trailer production vary only in emphasis. An extensive 4-lane highway network will encourage sales as well as allow direct access to consuming markets.

Accordingly, travel trailer manufacturers will tend to locate on 4-lane highways, preferably near the hub of a system providing North-South and East-West access to the marketing territory. Manufacturers of the larger mobile homes will be similarly concerned, but will likely place the added requirement for nearby access to the interstate system.

Although some inbound materials will arrive by truck, the vast majority of shipments will utilize rail. The freight on component parts is much less than on the finished product since parts can be nested, stacked, or otherwise shipped more compactly. Price competition among the industry, however, dictates the necessity for the more economical volume shipments and manufacturers will require rail service at new locations.

Waterway transportation will prove an asset to communities soliciting new trailer coach plants. While not a primary locational factor, the economies realized on inbound shipments and the potential for water-compelled rail rates will prove most attractive to location-seeking firms.

Labor Force Characteristics

Labor considerations present the next most significant, and perhaps the most sensitive, element in the location equation. Such elements as industrial mix, labor abundance, competitive labor requirements, labor and community attitudes, labor union activity, prevailing wage and fringe patterns, and the overall industrialization of a community all affect the long-term suitability of a location's available labor force. Moreover, the supply and demand relationship has a profound effect on labor costs.

It is significant to note that while Appalachia has much to offer the industry, the reverse also holds true. Skills utilized in trailer coach manufacture are basic to many industries, and yet, due to the repetitive nature of the manufacturing operation, can be rapidly taught to people with basic aptitudes. In addition, design and model changes will gradually upgrade the work force skill level.

The assortment of skills and semiskills utilized in the production of trailer coaches includes welding, sheet metalwork, assembly, woodworking, finished carpentry, wiring, pipe fitting and painting.

Labor Supply

Few executives expect to find a qualified existing work force at a new location. What they are looking for is a sufficient number of stable, trainable candidates with basic qualifications, to allow selective hiring procedures. This requires an adequate number of basically qualified candidates to permit screening of undesirable influences and to allow selection of those workers felt to be most adept and productive. Prudent location seekers will search for areas allowing a 4- or 5-to-1 selectivity ratio.

Today, there is no "typical size" for manufacturing plants of the industry. New locational activity involves plants ranging from 25 to 230 employees with expansion expectations running up to 1,000. For all practical purposes, however, the initial requirements of new branch plants will fall in the area of 100 to 150 employees, with males comprising over 95 percent of the work force. Further, a community's labor supply should facilitate expansion to 250-300.

Plants falling within the above category will thus require an available labor force exhibiting a potential of 1,250 males. Supply potential calculations are based on the effective labor drawing territory which, in turn, varies with an area's terrain, highway system, and the locations of labor competitors.

Recent plant location experience indicates that industry manufacturing units are locating in communities with populations ranging from 3,700 to 32,000. Activity in the 13,000 to 15,000 range was most pronounced; however, one town on the low end of the scale successfully attracted 2 plants employing a total of 350.

In general, manufacturers will avoid communities with a predominant durable goods industry or an area of current or potential labor union activity. Locations with low manufacturing employment or with a predominant employer exhibiting a low-wage bias will be most attractive.

Labor Costs

The competitive nature of the industry places a large significance on the element of labor costs. Locations selected will provide moderate wage and fringe patterns with a minimum of foreseeable pressure.

As might be expected, the industry's average hourly rate of $2.19 in 1964 is well below the comparable $2.71 durable goods average. However, much of the large production concentration in the East North Central States must submit to the pressures created by the area's high degree of industrialization. Accordingly, most areas of Appalachia can offer substantial savings.

Discussions with manufacturers indicate that producers in the Great Lakes States are faced with plantwide average hourly earnings between $2.25 and $2.45. Comparative wages in most Appalachian areas range between $1.55 and $1.85 and reach up to $2.10 in certain northern sectors.

Today's plant of 100 workers would produce close to 900 units each year. Based on the midpoint of the Great Lakes and predominant Appalachian wage spreads, Appalachian manufacturers are afforded payroll savings of $135,200 annually. This amounts to $150 per unit or 2.7 percent on the average selling price. Moving to the extremes, the total annual payroll savings equal $187,200 or $208 per unit--3.7 percent on the average purchase price.

Further savings are available as manufacturers adopt the area's prevailing fringe benefit patterns. Great Lakes producers are usually faced with 6 to 8 holidays, 3 weeks' vacation after 10 years, company-paid insurance and pension programs, and paid work breaks of 20 to 30 minutes. While patterns vary widely throughout Appalachia, a savings in manufacturer's cost of over 25 cents per hour would not be unusual. This provides an additional annual benefit of $52,000 or $57 per unit and 1 percent on the selling price.

Other Locational Considerations

Typical, general purpose, serviced sites of 5 to 20 acres will satisfy most new locations. Direct highway access and a rail siding is of major importance and preferred choice will go to those sites already serviced with utilities.

Investment in land, equipment and buildings is not a primary factor; however, goods-in-process and inventories can be substantial and locations where these items are not subject to local taxes will provide additional benefits to the trailer coach manufacturer.

Many firms, both large and small, are looking for full build and leaseback financing. The high percentage of small firms in the industry would tend to limit the availability of industrial revenue bond issues in those states where such financing is based solely upon the individual corporation's credit. These areas can remain competitive through the judicious application of local subscription or mortgage financing procedures.

The cost of utilities is not a significant factor in the location decision.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

Opportunities for effective public investment, actions and activities are unique in the trailer coach industry. Moreover, many of these opportunities are complementary to the expressed objectives of other phases of the Appalachian program, and all of them are equally applicable to the entire Appalachian Region.

On the contrary, however, little can be done to enhance the area for special purpose vehicle production, which will grow as the area matures, becomes increasingly urbanized, and industrial growth broadens the market by providing new purchasing power to communities and individuals alike.

Accordingly, this section of the report places emphasis on the extent to which public activity and investment can influence increased expansion and locational activity of the trailer coach industry.

Market Development

That Appalachia can effectively serve a broad potential market has been demonstrated in Section I. The importance of market orientation to new plant locations is stressed in Section IV. Remaining, is development of the yet unrealized potential within Appalachia itself--a potential that is surprisingly sensitive to many aspects of public investment and action.

Mobile Home Parks

A chronic shortage of suitable sites ranks as the primary industry problem. The Mobile Home Manufacturers Association (MHMA) estimates that only a little over one-fourth of existing parks meet minimum quality requirements and are generally below the standards acceptable to most mobile homeowners. Parks presently number 22,000 and provide over 1 million spaces. They are increasing at the rate of 1,100 a year; yet, most contain less than 100 spaces providing an added capacity which compares poorly with the 1965 output of 216,470 units. Moreover, much of the existing capacity is unsuitable for the new, larger model mobile homes.

Park spaces in the Northeast have been full for the past 5 years. While sales in this area continue to increase, leading executives feel that the potential is two- or threefold if the site situation can be resolved.

Estimates place park development cost in the range of $1,000 to $2,000 per space depending on the number and quality of utility facilities--including paving, landscaping, and recreational community facilities. Parks situated at the fringe of an urban community will encounter raw land costs of $250 to $500 per acre. The maximum density, unless otherwise controlled by zoning laws, is 10 spaces per acre.

In a few cases, loans have been made by the Small Business Administration for park development. More frequently, in recent years, financing is under the FHA insured loan program which provides a maximum of $1,800 per space and $500,000 per mortgage, over a period of 15 years. In no event can the loan exceed 75 percent of the estimated value on the completed project. The average net return to operators is 12 to 22 percent.

Planning of the trailer park is critical to the financial success of the project. Preferably, no more than one-third of the raw land should be allocated to trailer spaces. Remaining land is needed for access roads, community facilities, and open areas. Care must be taken to design the establishment as a permanent subdivision. Assistance is available from the Mobile Home Manufacturing Association.

The mere presence of an attractive trailer park aids in creating a market. Development can be speeded by extending the FHA mortgage period to 30 years, by more active participation of the SBA, and by encouraging local development groups to endorse or sponsor such activities. Some thought might be given to directly subsidized units, as discussed later in this section.

Perhaps the most effective public activities designed to boost the market will be those directed toward improving the image of mobile home living. The permanent nature of mobile homes of today has been established. Wheels are added merely to facilitate transportation to the homesite. They remain attached, in many instances, to gain the lower tax treatment afforded a vehicle.

As would be expected, the problems of urban blight and obsolescence that plague most of the older communities also confront owners of long-established mobile parks. Community action programs, financial assistance, and the establishment of a common set of standards would aid in converting unsightly parks into attractive settings. What is also needed, however, is a rigid manufacturing code binding all mobile home production and designed to insure the permanency of construction while safeguarding against obsolescence.

First priority for effective action must go to development of a uniform zoning ordinance designed to regulate the orderly development of attractive, well-planned mobile home parks. Close coordination with the American Society of Planning Officials, the National Association of Counties, and the Mobile Home Manufacturers Association would prove beneficial. Efforts must then be focused on soliciting adoption by all areas within Appalachia.

Community Regulations

Up to recent times and in most communities, obstacles have been placed to hinder the development of mobile parks. In fact, there are many communities that forbid such use of any land within their borders. A relaxation of the regulations against mobile homes in the "good parts of town" would no doubt create a real boom in the already thriving market.

Reasons for the above have been indicated as threefold: (1) the unsightly and transient nature of older trailer parks; (2) a housing density per acre which was often triple that allowed for residential space in the lowest zoning classification, increasing the cost and burden of serving a highly concentrated group of citizens; and (3) taxation policies which treated the mobile home as motor vehicles or personal property, thus seemingly escaping the proper share of local taxes.

The image of mobile home living is improving. It will be further enhanced as communities remove the zoning restrictions that frequently limit park development to nonresidential or industrial areas. Statutory action on the community level can equalize taxes and limit space density as well as open new areas for controlled development. Treatment of mobile home developments in the same manner as housing subdivisions, with review and approval of construction plans, layout, and utility services, will assure programs which are in line with community objectives.

Public or Subsidized Housing

The permanency of mobile homes has been demonstrated previously. Models are now available which run to 20 feet in width and over 70 feet in length, providing in excess of 1,400 square feet of living space. Styling comes in a broad range following modern lines, and units are completely furnished in every detail, including major appliances.

The ramifications of the above are many. Community improvement programs on the federal, state, or local level would do well to consider the benefits of permanently established "mobile" homes. Low initial cost and low maintenance expenditures combine with the ease of acquisition and installation to warrant attention in these programs. Moreover, some of the more underdeveloped areas in Appalachia lack the necessary know-how or skills required to erect the more conventional subdivisions.

Another potential is also worthy of consideration. The attraction of a large new industry to an underdeveloped area will frequently mean a rapid change in population. Housing must be provided for both the construction workers and the plant staff. Whether this be transitional or of a more permanent nature, "mobile" homes provide the most economical means to rapidly satisfy the need. Since most communities could not finance an undertaking of any scale, federal assistance could be effective in assuring new industry of adequate housing.

Mobile Home Financing

A new mobile home costing $5,000, with 25 percent (or $1,250) down, would require a monthly payment of $73.39 based on a 6.5 percent mortgage of 5 years. Another $25 to $50 is required for space rental and additional charges are made for utilities. Financing usually involves a chattel mortgage paralleling treatment of the automobile; however, more institutions are beginning to recognize the permanent nature of new mobile homes and 7-, 8-, and, in some cases, 10-year financing is now available.

Prior to liberalizing financial arrangements, a stringent construction code should be adopted and made binding on all manufacturers. Some states, notably California and Idaho, already have such laws. The "Gold Seal" code of the Mobile-home Craftsmen's Guild and the American Standards Association code ASA 119.1 would form a good base for similar legislation in Appalachian States.

Units manufactured to the code might then warrant treatment under the FHA-insured loan program, extending amortization periods to 15 or 20 years and lowering the required down payment. The effect would be to slow down the rapid rate of depreciation and give rise to a used mobile home market while, at the same time, placing the purchase of a home within reach of a larger number of people.

Recreational Facilities

Substantial recreational facilities within Appalachia indicate a large travel trailer potential. However, parks must be open to travel trailer use. While some go so far as to set aside sections exclusively for travel trailers, others prohibit them.

By extending to travel trailers, the code requirements mentioned earlier, the government can assure compliance with Park Service regulations of safety and sanitation. The opening of all Federal and State parks to trailers would then not only encourage the utilization of park facilities, but also broaden the scope of the travel trailer market.

Appalachian locations now provide access to a large existing market. As the objectives of the Appalachian Regional Commission are met, the development of the Region will create a new purchasing power for the inhabitants. Thus, from the long-range standpoint, is the development of an internal market.

Highways

The significance of the highway system to trailer coach manufacturers is paramount. First, there is the limiting effect on market service. Additionally, the competitiveness of a location is affected by inbound and outbound freight charges.

An adequate system of primary and feeder highways will certainly encourage the purchase of trailer coaches. The travel trailer is useless without access to recreational facilities. Mobile homes must move from the plant site to homesite. Highway programs already proposed for Appalachia appear to be adequate. However, new roads should be designed to permit trailer coach movement without undue restrictions and existing restrictions on other federal, state, and local highways should be removed or liberalized where such can be justified from the standpoint of safety.

Other Areas of Consideration

While not a significant locational factor to date, it is felt that the industry would be somewhat sensitive to vocational education programs. The skills required are basic; the skill level is rather unsophisticated. Primary areas of emphasis should include welders, carpenters, electricians, sheet metal workers, assemblers, maintenance mechanics, and plumbers.

Rail service, as noted earlier, is a prime requirement of industry. Programs designed to encourage rail development to locations otherwise suitable for new trailer coach plants will assure full consideration of these areas in future locational decisions.

Appendix A

SELECTED INFORMATION SOURCES

Published Information

(1) Annual Survey of Manufactures, 1964, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

(2) 1958 and 1963 Censuses of Manufactures, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

(3) Interindustry Employment Requirements, July 1965, Monthly Labor Review, Bureau of Labor Statistics, United States Department of Labor.

(4) Concentration in Manufacturing, Industry Summaries, Studies in Business Economics, No. 91, 1966, National Industrial Conference Board, New York.

(5) County Business Patterns, 1964, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

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(9) Investment Statistics, Quarterly Survey Capital Appropriations, 1959-1966, National Industrial Conference Board, New York.

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(11) Many annual reports for individual companies.

(12) Moody's Industrial Manual, 1966, Moody's Investors Service, Inc., New York.

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(14) Consumer Bulletin, June 1964, Consumers' Research, Inc., Washington, D.C.

(15) Construction Review, February 1965 and July 1966, U.S. Department of Commerce, Business and Defense Services Administration.

(16) Economic Leaflets, April 1966, Bureau of Economic and Business Research, College of Business Administration, University of Florida, Gainesville, Florida.

(17) The Mobile Home Manufacturing Association, Chicago, Illinois.

(18) The Municipal Year Book, 1966, The International City Managers Association, Chicago, Illinois.

Unpublished Information and Personal Contacts

(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Manufacturers of trailer coaches and special purpose vehicles inside and outside Appalachia.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 12–THE INSTRUMENTS AND CONTROLS INDUSTRY

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SUMMARY

The process control industry will grow faster than many other sectors of the instrument and control group. Teaming up with computers, the control industry will substantially automate the material process operations common to the petroleum, steel, plastic, and chemical industries. Annual growth rates exceeding 12 percent in many product lines will require additional assembly plants.

The great majority of Appalachian labor market areas cannot readily supply the mechanical skills to complement a vertically integrated plant. For that reason, assembly operations are emphasized in this report. Machine operations are suggested for one plant. Assembly operations are recommended for a second plant. Recent location trends have decentralized the manufacturing function to take advantage of large labor surpluses such as found in many areas of Appalachia.

With the exception of Pennsylvania, the prevalence of the industry within Appalachia is extremely low. Major instrument plants that have recently located in Tennessee, North Carolina, and Pennsylvania have reported very satisfactory performance.

The instrument and control industry has 14 large publicly owned corporations that share just about 50 percent of the $4.1 billion market. Two or three firms concentrate on each major product line such as gas meters, temperature controls, and process controls. Scientific instruments, in particular, have a broad base of small companies, each specializing in a particular field.

The economic impact of a process control assembly plant location in Appalachia would be most pronounced. For every dollar of gross output, 54 cents is spent for goods and services. The ripple effect of wages and salaries, coupled with that spent on goods and services, will inject new money into Appalachia.

Public investment policies and activities that will titivate Appalachia should have the following priorities: (1) assist municipal bonding programs for sewage treatment, refuse disposal, and water treatment; (2) construct, expand, and improve general aviation airports for private aircraft, and expand and improve commercial airports; (3) construct and expand regional vocational training centers oriented to the needs of industry; (4) construct highways connecting to U. S. Route 81, and between central Pennsylvania and southern New York State; and (5) coordinate water resource programs with future recreation needs.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically Standard Industrial Classification industry codes 3611, Electrical Measuring Instruments and Test Equipment; 3811, Engineering, Laboratory, Scientific, and Research Instruments and Allied Equipment; 3821, Instruments for Measuring, Controlling, and Regulating Physical Changes; and 3831, Optical Instruments and Lenses.

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

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I. PROFILE OF THE INDUSTRY

Size

Sales of industrial, scientific, and technical instruments are predicted to hit at least $4.6 billion in 1966, or about 12 percent higher than the $4.1 billion estimated for 1965. In 1964, approximately 195,000 were employed by this industry group, with wage and salary remunerations of $1.28 billion. Value added by manufacture for 1964 was $1.57 billion. In the same year, the value of shipments in the industry was $3.46 billion.

Instruments and controls include the following Standard Industrial Classifications: 3611, electrical measuring instruments and test equipment; 3811, engineering, laboratory, scientific, and research instruments and allied equipment; 3821, instruments for measuring, controlling, and regulating physical changes.

Table 1.

Rankings of the durable goods industries 1/

(Numbers in millions)

Industry rank	Employment		Value of shipments	
	TOTAL	9.199	TOTAL	$232,170
1	Transportation equipment	1.624	Transportation equipment	57,846
2	Machinery	1.537	Primary metals	40,036
3	Electrical machinery	1.483	Machinery	34,219
4	Primary metals	1.179	Electrical machinery	31,054
5	Fabricated metals	1.116	Fabricated metals	24,877
6	Stone, clay, & glass	.581	Stone, clay, & glass	12,973
7	Lumber & wood	.562	Lumber & wood	9,885
8	Furniture	.386	Instruments	6,616
9	Instruments	.309	Furniture	6,302
10	Ordnance	.234	Ordnance	4,421
11	INSTRUMENTS & CONTROLS 2/	.195	INSTRUMENTS & CONTROLS 2/	3,457

Industry rank	Capital expenditures		Value added by manufacture	
	TOTAL	$7,130	TOTAL	$115,744
1	Primary metals	1,887	Transportation equipment	23,961
2	Transportation equipment	1,297	Machinery	19,762
3	Machinery	946	Electrical machinery	18,039
4	Electrical machinery	889	Primary metals	16,732
5	Fabricated metals	728	Fabricated metals	12,636
6	Stone, clay, & glass	626	Stone, clay, & glass	7,520
7	Lumber & wood	369	Lumber & wood	4,361
8	Instruments	165	Instruments	4,333
9	Ordnance	117	Furniture	3,225
10	Furniture	106	Ordnance	2,871
11	INSTRUMENTS & CONTROLS 2/	62	INSTRUMENTS & CONTROLS 2/	1,573

1/ Source: 1964 Annual Survey of Manufactures.

2/ Includes statistics only for SIC's 3611, 3811, 3821, 3822, and 3831.

As can be readily seen in Table 1, the industry is small compared to the durable goods industries in every form of measurement used in this study. Similar in size to the office machinery industry and others in The Appalachian Location Research Studies Program, instruments and controls are relatively small in magnitude, but important in locational fit and impact.

Many of the statistics for this industry overlap into the electrical component parts industry covered in Report No. 5 of this program. Attention is now focused on the important sectors of this industry group that have not been covered in other reports. These include SIC's 3811, 3821, and 3822, and represent $2.3 billion of the $3.5 billion in 1964 sales for the entire instruments and controls industry. Table 2 provides a measure of this portion of the industry.

Table 2.

Industry shipments by production segment 1/

(Percentages based on dollar value)

SIC	Classification	Value of shipments	Shipments % of total
3821	Mechanical measuring and controlling devices	$1,228,212	53.3
3822	Automatic temperature controls	550,077	23.9
3811	Scientific instruments	525,777	22.8
	TOTAL	$2,304,066	100.0%

1/ Source: 1964 Annual Survey of Manufactures.

Products and Markets

Mechanical measuring and controlling instruments are rapidly being matched as the leader in this industry group by the electrical measuring and instruments sector. Greater use of electrical measuring devices has come about with the development of in-process controls using computers for regulation instead of manual valve turning and gauge watching. Dynamic rather than static measurement has placed electrical measuring instruments in the fore. Continuous processes in the chemical, petroleum, glass, pulp, paper, steel, synthetic fiber, and rubber industries represent the market which is presently stimulating growth for this sector of the control industry.

Value of shipments for products within the 3 major SIC's here under study (3811, 3821, and 3822) are shown in Table 3.

Table 3.

Value of selected product shipments 1/

SIC	Product class	Value of shipments ($ million)
38111	Aircraft flight nautical & navigational instruments & automatic pilots	310.3
38112	Laboratory & scientific instruments	209.6
38113	Survey & drafting instruments	119.2
38211	Aircraft engine instruments, except flight	48.9
38212	Integrating meters, nonelectrical type	164.8
38213	Industrial process instruments	584.1
38214	Motor vehicle instruments, except electric	108.3
38216	Other mechanical & controlling instruments	116.8
38220	Automatic temperature controls	461.3

1/ Source: 1964 Annual Survey of Manufactures.

Basically, instrumentation is measuring a physical property such as temperature; control is keeping the physical property within pre-established limits; and regulation is the act of control which closes a valve or raises the heat, for instance. Measure, control, and regulation are the keys to these products used in manufacturing processes.

Process instrumentation and control is the largest and fastest growing sector of this industry group. Two types of process instrumentation are (1) electrical and (2) pneumatic. Electric process controls are readily adapted to a central computer control and regulation whereas the pneumatic controls are more adaptable to manual or automatic regulation in the field. Pressure release valves on domestic hot water boilers are a typical pneumatic control.

Mechanical instruments include products which indicate, record, measure, and control temperature (except automatic temperature controls--SIC 3822), pressure and vacuum, fluid flow and liquid level, mechanical motion, rotation, humidity density, acidity, alkalinity, and combustion; dial pressure gauges; physical property testing apparatus such as hardness, tension, compression, torsion, ductility, and elasticity testing apparatus.

Gas and water meters are major products which are in common usage and familiar to everyone. Parking meters, turnstile counting mechanisms, and transportation fare registers are other common products within the mechanical instrument group.

This broad spectrum of products covers markets dependent upon industrial activity, building construction, government and private research and development, and public and private transportation.

Plant Ownership and Size Structure

Within Appalachia there are only 13 plants employing more than 100 people in the SIC 3811, 3821, and 3822 categories, while the United States has 195 plants employing 100 or more. If plant size could be described as "typical," it might be said that there are a great number of small 5- to 20-employee plants among the 1,366 establishments in the United States. Among major producers, the typical plant employs about 450 people.

There is one industry leader which is diversified in its product line outside instruments and controls. The sales of this company approach $700 million annually. Thirteen other industry leaders have $50 million to $200 million annual sales, with only 4 of these firms breaking $100 million. Since these 14 leaders have aggregate annual sales of only $1.9 billion, it is clearly evident that there are a great number of small firms which account for the other $2.7 billion sales within the industry. At least 80 percent have less than 50 employees.

Geographic Prevalence

Appalachian specialization in this industry is dismayingly low when compared to the burgeoning growth which characterizes all branches of instrumentation. Between 1962 and 1966, Appalachia attracted only 17 new plants and was credited with 12 plant expansions. As of 1963, Pennsylvania had 30 plants--the leading figure in Appalachia.

In the United States there are 1,366 establishments (counting those firms primarily engaged in the production of instruments and controls) other than electrical or optical (SIC's 3811, 3821, and 3822). The concentration of these firms is in the Middle Atlantic and East North Central States, as shown by Table 4. The industry shows a definite history of locating near the heavy industrial and population centers of the country.

Table 4.

Regional distribution of establishments 1/

Geographic area	SIC 3811	SIC 3821	SIC 3822	Total
New England	66	79	10	155
Middle Atlantic	159	209	19	387
South Atlantic	43	33	6	82
East North Central	118	156	39	313
East South Central	8	12	2	22
West North Central	24	23	7	54
West South Central	46	38	3	87
Mountain	14	13	2	29
Pacific	115	106	16	237
UNITED STATES	593	669	104	1366

1/ Source: 1963 Census of Manufactures.

As can be readily seen in Table 5, there is no indication of Appalachian specialization. Pennsylvania indicates a high location incidence.

Table 5.

Establishments within the Appalachian Region 1/

State	SIC 3811	SIC 3821	SIC 3822	Total
New York	1	1	-	2
Pennsylvania	15	13	2	30
Maryland	1	-	-	1
Virginia	-	-	-	-
West Virginia	3	1	-	4
Ohio	1	-	-	1
North Carolina	1	-	-	1
South Carolina	-	1	-	1
Georgia	-	-	-	-
Kentucky	-	1	-	1
Tennessee	3	2	1	6
Alabama	-	1	-	1
TOTAL	25	20	3	48

1/ Source: 1963 Census of Manufactures.

Economic Impact

As can be seen in Table 6, the industry tends to purchase scientific and controlling instruments from others in the same industry, thus creating a potential cluster response for location activity. Similar clusters have been evident in Boston's Route 128 complex, the research centers circling Washington, D. C., and Huntsville, Alabama.

Table 6.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from other establishments	Scientific controlling instruments
Ordnance & accessories	$ 28.39
Rubber & miscellaneous plastic products	11.47
Primary iron & steel manufacturing	18.67
Primary nonferrous metals manufacturing	38.71
Stampings, screw machine products, & bolts	17.35
Other fabricated metal products	15.92
Metalworking machinery & equipment	11.80
Office, computing, & accounting machines	12.71
Electric industrial equipment & apparatus	33.16
Radio, television, & communication equipment	10.41
Electronic components & accessories	28.12
Motor vehicles & equipment	14.12
Aircraft & parts	15.61
Scientific & controlling instruments	67.08
Transportation & warehousing	10.42
Wholesale & retail trade	45.92
Business services	14.40
Gross imports of goods & services	21.13
Business, travel, entertainment, & gifts	22.25
Other industries	107.60
Total purchases	$ 545.24
Value added	454.76
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business.

Nonferrous metals, brass and copper in particular, represent sizable portions of outlay for materials and services going into these products. Electrical industrial equipment similarly stands out as having a significant impact on derived demand from this industry.

Impact on the local economy is apparent from 2 factors: (1) $46 of every $1,000 goes to wholesale and retail establishments that are generally located nearby; and (2) 99,000 production workers employed in the manufacture of scientific instruments (SIC 3811), mechanical measuring devices (SIC 3821), and automatic temperature controls (SIC 3822) receive $565 million annually in wages. In 1964 weekly earnings for production workers of scientific instruments averaged $120, or $6,240 annually, while production workers of mechanical and automatic controls averaged $104 weekly and $5,400 annually. As a comparison, the durable goods industry's weekly gross earnings averaged $112, and the nondurable industry's averaged $91. Between one-third and one-quarter of the total employment is assigned to women, who have the dexterity required for this type of production.

11. THE INDUSTRY'S PROSPECTS FOR GROWTH

Sales

This section focuses on the future growth from the standpoint of individual markets for instruments and controls rather than the individual products. As mentioned earlier, instruments and controls are manufactured by several industries not well defined for statistical comparisons.

The total market represented $4.1 billion in 1965, up from $3.5 billion in 1964, for a healthy 17 percent annual rate of growth. According to reliable sources, research, industrial, and educational outlays for instruments will be about $380 million in 1966. Sales of aircraft and navigation instruments should increase from $470 million in 1965 to $585 million in 1966. Aircraft engine instruments alone will increase from $76 million to $95 million, according to industry estimates. These estimates are based on a 30 percent increase in military production and a 20 percent increase in civilian production.

Industrial instrumentation has by far the most potent impact on the industry's sales. At least a 9 percent increase in plant and equipment in 1966 will mean $835 million sales in this sector of the market. Chemical, petroleum, and the primary metals industries will provide the greater share of this industrial market.

A recent slowdown in home building construction may adversely affect the automatic temperature control, water and gas meter market forecast of nearly $500 million in 1966. Controls for domestic heating, cooling, and major appliances could also experience a short-term plateau period in sales growth due to credit restrictions, but demographic patterns and pent up demand could easily overcome this domestic market's slight deceleration due to credit restraints.

Sales of electronic testing and measuring instruments will grow faster than any of the other instrumentation products in the next few years. Military contracts and their use in radio, television, and automobile repair shops, research and development laboratories, and in manufacturing will contribute to accelerated growth that will surpass $550 million in sales during 1966, according to several reliable sources.

Electrical instruments that measure both electrical and nonelectrical quantities will grow from $315 million in 1965 to $340 million in 1966, and approach $450 million by 1970. Their sales are derived from aircraft production, industrial capital outlays, and anticipated electrical power generation.

Federal procurement of meteorological, hydrological, and oceanographic instruments will increase 16 percent in 1966, according to preliminary budget data.

Profits

Profits have been keeping pace with sales. The ratio of net income to net sales has ranged around 5 percent. Table 7 represents data on 14 selected publicly owned firms in the industry.

Table 7.

Three-year average of profit ratios for selected firms in the instruments and controls industry 1/

Company	Net profits, percent on sales	Net profits, percent on gross property
A	4.0%	N.A.
B	3.9	16.6%
C	5.3	N.A.
D	5.6	N.A.
E	1.9	2.6
F	2.7	12.4
G	5.9	13.4
H	5.1	N.A.
I	3.8	9.2
J	7.0	10.9
K	6.6	N.A.
L	9.1	N.A.
M	7.7	17.0
N	5.6	13.0
Average of selected companies	5.3%	11.9%
Mechanical instruments industry median	5.47% 2/	

1/ Source: Moody's Industrial Manual, 1966.

2/ Source: Dun and Bradstreet, Inc.

High research and development costs are attributed to the progress toward instrumentation and control for the continuous process manufacturing industries. Close liaison between control manufacturers and the petroleum, fiber, steel, and glass industries has cost considerable time and energy. Payoffs in large contracts mature only with a low probability factor, and after many failures. Small firms in the industry apparently have a habit of specializing in a particular phase of instrumentation that may have only limited potential. Research and development costs for these firms have evolved over many years, frequently the work of 1 or 2 scientists. Profits for many in the field are marginal because they are unable to accurately measure research and development costs.

It therefore becomes apparent that the greatest potential for Appalachia lies with those firms in the instrument and control industry who have become established and are prepared for profitable production.

Table 8 provides a comparison of 80 firms sampled in the instrument and control industry. A broad range of profits is demonstrated from the lower to upper quartile. Particular note of the 1.20 net profit percentage of sales figures perhaps demonstrates the high research and development costs attributed to this industry. Of course, other costs could account for this low performance record.

Table 8.

Profit ratios in the instruments and controls industry, 1964 1/

	SIC 382 Mechanical instruments (49)	SIC 3811 Scientific instruments (31)
Net profits, percent		
On sales	8.62	7.56
	5.47	4.20
	3.30	1.20
On tangible net worth	19.76	17.53
	14.64	11.99
	8.42	3.73
On net working capital	31.71	28.17
	21.85	17.73
	11.90	4.44

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc.

Employment

Production employment tends to have a higher proportion of women employees who have the dexterity necessary to assemble delicate components. Between May 1965 and May 1966, the number of production workers employed in the manufacture of instruments and related products rose 13 percent (at a steady rate of increase each month). During the same period, production employment in the durable goods industries as a group rose only 8 percent.

The employment figures for some of the major firms in the industry between 1964 and 1965 reveal amazing growth indicators. Increases in employment range from 10 to 165 percent for these firms. Only 5 of 14 firms show gains of less than 8 percent, and only 1 reduced its employment.

Between 1958 and 1965 employment declined in both the scientific instruments industry (SIC 3811) and the mechanical measuring devices industry (SIC 3822). Employment in the manufacture of automatic temperature controls and electrical measuring instruments increased 20 percent in the same 7 years. Table 9 provides trend data on employment up to 1965.

Table 9.

Employment change in the instruments and controls industry 1958-1965 1/

Industry	All employees 1965 (000)	Percent change 1958-1965	Women employees 1965 (000)	Percent change 1958-1965	Production workers 1965 (000)	Percent change 1958-1965
Scientific instruments	69.8	(3.5)	15.9	(3.1)	35.7	(13.8)
Mechanical measuring devices	60.9	(0.2)	16.8	(6.1)	37.6	(5.8)
Automatic temperature controls	39.0	24.6	16.1	27.8	27.5	22.8
Electrical measuring instruments	58.0	25.5	23.7	17.9	37.9	18.1

1/ Source: Employment and Earnings - Establishment Data, Bureau of Labor Statistics.

Employment in the manufacture of electrical measuring instruments holds the greatest opportunity for the future. Growth in employment in this particular sector of the industry depends on the degree of automation in the steel, chemical, paper, and petroleum industries, while automation within its own industry is relatively impossible. Human hands and dexterity are necessary in the assembly operations, and trends to automate other industries can only benefit the instruments and controls industry.

Locational Activity

Some of the larger instruments and controls manufacturing establishments are located within Appalachia. On the average, Appalachia is the domicile for 8 percent of all the manufacturing establishments in the United States employing more than 50 people. This industry, with 485 establishments in the United States, and 40 within Appalachia employing more than 50 persons, fits the Appalachian average for all industry as a group. Table 10 represents all establishments, irrespective of size, and demonstrates that only 3.7 percent of all the instruments and controls manufacturing plants are located in Appalachia (95 of 2,640).

Table 10.

Locational activity for selected instruments and controls industries 1/ (Net change)

Industries	Establishments 1958	Establishments 1963	Net increase (decrease)	Percent change
Scientific instruments				
Total U. S.	567	593	26	4.6
Appalachian	29	25	(4)	(13.8)
Mechanical measuring devices				
Total U. S.	624	669	45	7.2
Appalachian	15	20	5	33.3
Automatic temperature controls				
Total U. S.	83	104	21	25.3
Appalachian	3	3	-	-
TOTAL U. S.	1,274	1,366	92	7.2
APPALACHIAN	47	48	1	2.1

1/ Source: 1958 and 1963 Censuses of Manufactures.

Appalachia has some of the larger plants, however, with 21 plants employing over 100 people and 2 employing over 1,000 each.

Since 1963, locational activity for this industry has been light within Appalachia. Substantial expansions and new plants were committed at each new site. North Carolina, Tennessee, and Pennsylvania benefited most from new plant and expansion investment. The new plants located in communities of 10,000 population or larger and represented investments in plant and equipment up to $4 million each.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Fruition of years of development comes only after products are economically manufactured and sold at a profit. In the past, research, development, and manufacturing were carried on at the same location, perhaps separated only by a building. Top management has only recently recognized that manufacturing for long-run, well-engineered products can be more profitably achieved in those areas where the necessary grades of labor are in ample supply. The labor market in many of the North Central and New England manufacturing areas, where instruments and controls have centered, became extremely tight shortly after 1961. Locational activity has been accelerated since then.

Once a product is developed, complete with engineering detail on each step of manufacture, there is generally a pilot operation or production line established to debug the process and time each operation on the line. Experience in plant location shows that the manufacturing operations, often meeting requirements of skilled tool and die makers, remain as close as possible to the engineering facilities for the purpose of liaison in design change and flexibility in the machining of expensive raw materials. Access to outside subcontractors is another reason that initial stages of manufacture remain close to engineering.

Assembly of raw materials is broken down into relatively simple steps requiring female labor dexterity, but no particular education. Bench assembly lines with slow conveyor belts carrying the product to each stage of manufacture typify the heart of the assembly plant operations.

Raw Materials and Materials Handling

Very successful manufacturing operations have been established by dual-plant operations. The first plant forms the raw material into shapes ready for assembly; the second plant assembles and ships the product to market.

Copper and brass are prominent raw materials used in the manufacture of many instruments and controls. Refinements in metallurgy have broadened the applications of instruments and controls, exposing them to caustics and acids which require alloys of stainless steel, chromium, or molybdenum. Frequently, heavy electroplates of chromium, cadmium, beryllium, and other relatively rare metals are applied.

The stamping, forging, drawing, cutting, grinding, and deburring operations are followed by the necessary electroplating processes. Instruments and controls manufacturers often contract with outside firms who specialize in tube drawing, stamping, forging, and plating in short-run job shop operations. These operations are not always economical for the instruments manufacturer to engineer, set up, debug, and operate for short runs. The make-or-buy decision frequently entails more than direct costs, as time and alternative uses of space and labor frequently play a role in the purchasing decision.

Another important factor in maintaining a plant close to supporting subcontractors is the dependence on outside support for manufacturing processes in the early stages of fabrication.

Transportation between the parts plant and the assembly plant becomes nothing more than an extended production line. Tote bins, crates, and boxes that are capable of being knocked down flat or nesting at two-thirds of their volume are used for handling the materials in transit. Compaction of containers reduces return transportation costs. Production lead times allow third-morning delivery for less-than-truckload lots of parts in transit. Some manufacturers accumulate a week's production of parts and ship in truckload lots only once a week. Statistics show that 80 to 90 percent of this type traffic moves by motor common carrier, although return traffic of raw materials or finished products could justify company-owned equipment on this supply operation.

Manpower Utilization

At the assembly plant, handling is frequently the major task of male production workers. The main assembly is moved on pallets from storage to the assembly line by forklift trucks. When loaded on conveyors, the main assembly takes shape; small parts are attached by women and placed onto the continuous conveyor belt for the next step in the assembly. Small parts that are attached to the major assembly are usually carried to the production line in light wire baskets or tote bins by pallet lift trucks. Efficiency experts have designed containers specifically for easy access to parts, and damage-free transportation.

The nimble hands of women assemblers readily adapt to the steps of their operation within a few hours. Production engineering pays off at this stage of assembly where limited movements and decisions by the worker are necessary to maintain a quality assembly line.

Employment for a typical instrument assembly operation would require at least twice as many female production workers as male. A breakdown of general plant employment is as follows:

	Male	Female	Total
Shop	170	365	535
Office and technical	30	35	65
Total	200	400	600

Training is not a critical problem for assembly operations. One way of training assembly workers is to temporarily import workers from another plant. Assistance from nearby technical schools also aids in the training of workers, but in-plant training programs are effective for most assembly operations.

Unique manpower requirements for the more sophisticated lines of instrumentation might preclude their production in large areas of Appalachia where the high skills are lacking. Many aircraft and marine navigation instruments, for example, are produced in short runs not readily adapted to production line techniques. Therefore, the frame of reference to instruments and controls must be limited to those assembly operations where repetitive, mass production techniques use large pools of unskilled labor.

Product Innovation and Interproduct Competition

The current interproduct competition has been between pneumatic and electronic process controls. Pneumatic controls are actuated by metal bellows that contract or expand with valve pressure in liquid processing, for example. The bellows activate fulcrums which in turn open or close process valves that keep the flow of materials within pre-established limits. Pneumatic controls are generally adapted to field unit installations where fast response of the control system is required. Field unit implies that the control is installed outside the processing plant where flow control is immediate and automatic.

Electronic controls have taken a great share of the pneumatic market today, because of their direct compatibility with electronic computers. Pneumatic controls register the process flow on scaled graphs or gauges. Electronic controls register the flow on data processing tape, and a typewriter prints instructions for operators when exceptions to normal flow are signaled. Electronic controls tend to be centralized for operation, whereas pneumatic controls are decentralized. Electronic sensors attached to points of critical process flow immediately register in the central computer. Operation parameters that are not maintained are either automatically adjusted, or signaled to the central operations control room for a manual reset.

Current product innovations that combine instrumentation, computers, and controls have established an entirely new market in the field of raw material and liquid processing plants. Product applications initially in the petroleum and chemical industries have recently been applied to steelmaking, and water and waste treatment. From ore preparation to finished steel production, equipment can measure and control a myriad of process variables. Important information in this equipment is automatically organized, recorded, and evaluated, leaving the operators simple instructions to carry out massive control.

Product innovation in the water and gas meter line has been limited. A novel punched-tape meter reading has been developed, but widespread application will take years. Water and gas meters are known for their 30-50 year life expectancy, and large scale replacement would be impractical.

Within the broad spectrum of research and scientific instrumentation, innovation is rampant, but its importance in Appalachian industry is minor.

Distribution

Industrial instruments and controls are sometimes manufactured into standardized units and shipped to company branches. At the branch location adjustments and adaptation to customer specifications are made on the standard product. From this stage, the product is custom-built.

Because of the high degree of technical support necessary, sales, installation, and service are almost always vertically integrated within the instruments and controls manufacturing company. The more sophisticated the instrument or control, the greater the degree of manufacturer's participation in the distribution process.

Panel and cabinet systems of instrumentation and control are most often assembled, tested and shipped in large modules direct from the factory to the processing plant where the equipment is to be used. Connection to the process being controlled is made by factory-trained specialists.

3

Rugged gas and water meters are sold direct to the utilities who own them, even after installation.

Aircraft, marine, and motor vehicle instrumentation is sold directly to original equipment manufacturers. Only in the field of nonstandard transportation instruments does the distribution break off into parts distributorship and dealers. All standard equipment on an aircraft, boat, automobile, or truck are generally distributed only through authorized factory dealers. The supply of standard equipment is centralized and controlled by the original equipment manufacturer who redistributes to dealers.

Motor carriers handle 70 percent of the shipments which are larger than 50 pounds and moving less than 2,000 miles. Railroads handle the greater number of shipments beyond 2,000 miles, not as rail freight, but as carloading freight, which consolidates small shipments into full carloads. Railway and air express are used more extensively for these high-value products where transportation costs are minor considerations.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

An abundant female labor supply is the prime locational determinant for assembly operations of instruments and controls. Community environment is the second most important location factor. Access to markets, raw materials and supplies, utility costs, transportation, property taxes, and plant sites are relatively subordinate location factors for the instruments and controls industry.

Plant location experience has demonstrated that initially only assembly operations in the instruments and controls manufacturing processes have widespread locational fit within Appalachia. A very high ratio of skilled machinists and tool and die makers is the nucleus of labor requirements for forming the metal parts before assembly. There is a lack of skilled labor throughout the country, but it is predominantly lacking in most labor markets of Appalachia. Therefore, initial plant operations for the manufacture of instruments and controls must concentrate on assembly and shipping functions.

For this industry, location activity in Appalachia has been played in the minor key. Significantly, large plants manufacturing instruments and controls have been established within the past 4 years. Reports from top management, as recent as June 1966, were highly in favor of an Appalachian location, and, in fact, exceeded management's expectations. Statements from management on productivity, community environment, and labor costs were particularly pro-Appalachia.

It is the purpose of this section to point out the dominant locational factors which will provide mutual benefit to the manufacturer, its employees, and the community in which it locates.

Labor Supply

As pointed out in Section III under "Manufacturing Processes," skilled metal forming operations can be carried on at one plant, and assembly operations requiring lesser skills at a second plant, preferably in an area of surplus female labor. This interregional specialization of labor frequently benefits the manufacturer with lower labor costs, and the regional economy where the assembly plant locates.

Labor selection ratios of 8-to-1 have not been uncommon in recent Appalachian plant locations. One manufacturer reported that 8,000 applications to fill 600 positions were drawn from a 35-mile radius centered on a city of more than 60,000 people. While this may be an exceptional case, the attraction of workers to a new industry is most significant. In this area, textiles had been the dominant industry for employment.

Female assemblers are required for most of the instrument and control operations that would presently have locational fit within Appalachia. Section III demonstrates the high ratio of female assemblers in a typical operation now located in Appalachia.

In-plant training programs, in conjunction with state and local agencies, have proven to be both attractive and effective in establishing new plants. A typical commentary made public by a recent manufacturer's advertisment reads as follows:

> "Working together, the State of Georgia and our management people devised a curriculum, selected instructors, and began intensive training of 370 people. Specialized classes covered metalworking, electrical wiring, welding, and other skills. There was no obligation to hire or be hired. But at the end of the course, nearly 300 of the original 370 came to work for us." 1/

Training designed to fit the needs of the instruments and controls industry would include:

(1) shop assembly procedures and practice, i.e., spot welding, soldering, machine riveting, and coating,
(2) basic shop mathematics, i.e., decimal system, geometry without theory, derivation of areas, volumes and weights, and simple algebra below quadratic equations,
(3) machine tool operations, i.e., lathe, milling, grinding, boring, stamping, shearing, and bending,
(4) use of measurement instruments, i.e., micrometers, calipers, depth gauges, hardness indicators, and process graphs common to the instrument industry,
(5) basic electronic principles, i.e., power measurement, current flow diagrams, and simple laws of electricity,
(6) blueprint reading, i.e., mechanical drawing, and graphics.

1/ Source: World Journal Tribune, New York, September 27, 1966

All of the foregoing courses need not be required of a graduate. Qualification in just a few courses would prepare a worker for in-plant acclimation. Shop practice under controlled conditions of a training school can be far from the actual shop operations in industry. Many companies are willing to accept part-time trainees once they have passed a basic set of courses and show a mechanical aptitude.

Community Environment

Management and supervision who are necessary in establishing a new plant are accustomed to living in fully serviced communities. Normal requirements include clean water, adequate sewage treatment, trim neighborhoods, recreation areas, and above all, an educational system capable of placing students in a competitive position for entrance to major colleges.

The education problem is not limited to Appalachia. But even though it is widespread, this problem is a major consideration in choosing an industrial location. Management looks for educational systems with high standards. Stagnant systems that have pushed students through simply to make room for others are not preparing a work force capable of assimilating to technical job training programs.

Vocational training instruction within the education system that meets the needs of local industry receives the blessing of management when making a location decision. Curricula designed only for the purpose of keeping the less academic out of trouble is not adequate. Industry needs skilled workers that have perfected a specific trade.

Communities without provisions for water and sewage treatment, either at a plant location or within the residential area, are often overlooked as potential plant locations.

Management is becoming more aware of the obligation business has to society. Although not openly touted for fear of being labeled "soft," major concern for long-run pollution problems created by industry is now being displayed by industrial leaders. Sewage treatment and waste disposal facilities are common locational factors under scrutiny when a community is being studied for a plant location.

Access to recreation facilities is another location factor favoring a satisfactory family environment.

Access to Markets

Appalachia itself contains major markets for the instruments and controls industry. Prime customers for process instrumentation and control are: the steel producers in the Pittsburgh, Pennsylvania and Bessemer, Alabama areas; the chemical and plastic industry near Charleston, West Virginia; expansions at the aluminum mills in Cressona, Pennsylvania, Ravenswood, West Virginia, and Alcoa, Tennessee; and the entire textile industry, which to date has installed process controls primarily in the fiber plants.

Sales, service, and factory maintenance within one day's reach could be attractive locational features for the instruments and controls industry.

There is a market for aircraft and aerospace instrumentation in Albany and Marietta, Georgia; Huntsville, Alabama; and Hagerstown, Maryland; but the skills necessary for production might require importing labor to most areas. Industry experts believe the Huntsville instrument market is well covered at present.

Sewage treatment plants, eligible for federal assistance, will also generate a market for instrumentation and control.

Access to markets is not the most important location factor for the instruments and controls industry. Location does, however, provide an edge over competition when service is required.

Other Locational Factors

Raw materials and supplies for an Appalachian assembly plant would not be a major location problem. Finished parts ready for assembly could be shipped weekly in truckload volume from the New England, Middle Atlantic, or North Central States, and receive at least third-morning delivery. Shipments of less-than-truckload (LTL) lots could take 5 days in transit for isolated parts of Appalachia.

Local pickup and delivery agents for long-haul carriers may be the only means of access to some points. Transfer of LTL freight averages a 24-hour delay in transit. Appalachian communities have a distinct locational advantage when they are within the prescribed pickup and delivery authority of a long-haul motor carrier. With sufficient frequency and volume of traffic, a carrier with direct operating authority would be able to perform consistent third-morning delivery from just about any other point that it served direct on its system east of the Mississippi River.

Isolated communities that do not have express or rail service are not necessarily at a disadvantage, if local pickup agents concur with carloading companies at through rates competitive with motor carriers. Carloading companies tend to impose higher freight rate differentials, called "arbitraries," on traffic that must be tendered to an agent for delivery beyond a defined commercial zone. These arbitraries would make motor carrier rates more attractive. As mentioned earlier in this report, motor carriers handle 70 percent of the freight traffic generated by this industry.

Property taxes and utility costs are minor location factors that tip the scales in favor of a given community only when other factors are equal. Assembly plants can be shell buildings void of major metalworking machinery with materials handling machinery and office fixtures as the only equipment taxable.

Minimum site requirements for an instruments or controls assembly operation would be 20 acres. This allows ample room for expansion and flexibility in plant layout. There is a site fitting this requirement in most every Appalachian community.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

Without public investment to upgrade skills and improve communities, location of Appalachian plants in the instruments and controls industry will be generally limited to assembly operations. As pointed out in Section IV, community environment is a primary factor influencing selection of a location.

Instruments and controls manufacturing requires highly skilled engineers and machinists in its initial stages of manufacture. A plant locating today generally has to import these skills from other areas. These workers are accustomed to fully serviced communities with superior educational standards.

In the long run, skilled machine workers can be developed within Appalachia. Staffing of complete manufacturing facilities in the instruments and controls industry would then be possible. Machining and assembly operations under one roof are desirable when alternative labor pools are not available.

Other public investments discussed in this section would have a secondary impact on plant location for this industry group.

To Enhance Community Environment

Education

The greater portion of community budgets is allocated to education. Funds supplementing these budgets would assist those Appalachian communities with insufficient tax base to provide even minimum standards.

Many Appalachian communities cannot afford the salaries that are paid to teachers by industrial or urban areas with a sufficient tax base. Teachers tend to select the higher paying communities, which, in effect, places many areas of Appalachia at a disadvantage.

Engineers and management staffing an instruments and controls manufacturing plant would anticipate an educational system capable of placing students in a competitive position for entrance to college.

Local responsiveness to the federal and state assistance available for education would be the initial step in supplementing the local school budget.

Water and Sewage Treatment

Funds allocated to the treatment of water and sewage will benefit not only a particular community, but an entire river basin where effluents are discharged.

Personnel moving into a new community anticipate standards of health at least as high as the community from which they moved. These community refinements are watched by top management who must maintain a low turnover among their skilled personnel. Companies cannot afford to lose heavy investments in engineering talent and trade secrets in a plant move.

Recreation Facilities

Outdoor activities are attractive to all walks of life. Water and forest conservation programs should be coordinated with the need for fully developed recreation facilities within close proximity of major cities. Secondary emphasis should be directed to camping sites, fishing areas, and the like located in the more isolated areas.

Vocational Training

In the long run, higher education standards for many parts of Appalachia will contribute to internal generation of industrial growth. The direct short-run programs to boost Appalachian industry must center on vocational training schools as outlined in Section IV under "Labor Supply."

The Appalachian Act provides funds for the construction of more vocational centers in the region. Future manpower needs of the instruments and controls industry are outlined in Section III; and in Section IV the specific skills required for this industry are detailed under "Labor Supply." Additional funds may be required to perpetuate the mechanical labor skills in areas where the instruments and controls industry locates.

Airports

Isolation and lack of adequate transportation has held back Appalachian growth. Commercial air passenger service and general aviation airports must be expanded and improved in communities that want to attract the instruments and controls industry. Feeder airlines should be within one hour's driving time.

Liaison to suppliers, customers, and other company plants will enhance locational activity, particularly in areas where surface transportation must wind with the topography. Improved community airports for private planes and air-taxi service will contribute to the attraction of instruments and controls manufacturers. Expansion and improvement of commercial airports will also assist in industrial growth.

Highways

Parts for assembly and finished products to customers move predominantly by motor carrier in this industry.

Corridors from the East North Central States and the New England area will move parts from the potential machinery plants. Finished products would be shipped to a national market from Appalachia. The petroleum market, for example, is in Louisiana, Texas, California, and Oklahoma. East-west feeder highways that connect into U.S. Route 81 running the length of the Shenandoah Valley would fit the needs of supplying this $30 million market via a "fair weather" southern route. East-west corridors in New York State and a central highway running north to south in Pennsylvania would tend to open areas to supply and markets.

Heavy concentrations of the instruments and controls industry are within Pennsylvania. The computer industry centers in Tioga and Broome counties of New York State. Connecting the two areas by highways will enhance the growth of both the computer and process control industries where each are dependent on the other for a large common market.

Appendix A

SELECTED INFORMATION SOURCES

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(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Manufacturers of instruments and controls inside and outside Appalachia.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:
REPORT NO. 13–THE NONCELLULOSIC SYNTHETIC FIBER INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such industry, specifically Standard Industrial Classification industry code 2824, Noncellulosic Man-Made Fibers.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

The noncellulosic synthetic fiber industry (SIC 2824) invested new capital expenditures of $164 million in 1964--an amount exceeding the individual industry-wide expenditures of leather, tobacco, and apparel manufactures. Industry employment in 1964 ran to 44,318 and shipments exceeded $1,580 million.

In terms of output (pounds), cellulosic and noncellulosic production were relatively equal. Significantly, the value of shipments and the value added by manufacture favored noncellulosic production by a factor of 2 to 1. Nylons claim the largest share of output (55.4 percent), with polyesters and acrylics sharing about equally in the remainder. Apparel and home furnishings combine to account for over 68 percent of the market.

No less than 56 companies operate 82 locations producing the noncellulosic fiber. The industry leader controls roughly 50 percent of domestic capacity. Fully one-half of the plants employ over 1,000 workers.

Appalachia counts 20.7 percent of the manufacturing establishments among its industrial population. A strategic geographic position assists the area to a rather high degree of specialization. This existing population, as well as new locations, is attracting new private investment in facilities producing raw materials or chemical intermediates.

Projections of consumption over the next 5 to 7 years indicate average annual growth rates of up to 12 percent on nylon fiber and 30 percent on polyester and spandex fibers. Currently the industry is operating at 87 percent of capacity. Much new capacity has already been announced or is in the planning stages. Some industry representatives fear over-capacity in the next five years. Most agree that new locational activity will persist.

New locations for plants of this industry will be positioned in a broad region defined by the company's marketing objectives. Precise location within the region will depend on finding a locale which satisfies the following: (1) large acreage sites with adequate surface and/or ground water supplies; (2) a suitable and abundant labor supply; (3) minimum total freight and inventory costs; (4) economical fuel and power; and, (5) a tax climate conducive to long-term operations. In addition, community and recreational amenities are important due to a large number of professional and management personnel relocations.

Public investment policies and activities would be most effective when directed to providing a more suitable labor force through vocational training tuned to the needs of the industry; providing training assistance during plant start-up operations; completion of the Appalachian highway corridor program; upgrading secondary highway networks surrounding communities in the 25,000 to 40,000 population range; fostering the development of power rate structures competitive with TVA; and the stimulation of community improvement programs. Reliance on rail service dictates the necessity of actions designed to induce carriers into areas which are otherwise competitive. The extension of the inland waterway system within Appalachia would prove an added attraction for those communities with direct access to these facilities.

I. PROFILE OF THE INDUSTRY

Size

The production of noncellulosic synthetic fibers is covered by Standard Industrial Classification (SIC) 2824. In Table 1, this industry is compared with the total chemical and allied products industry (SIC 28) and the other nondurable industries in 1964. As can be noted from the table, the overall chemical industry ranks extremely high in both value added by manufacture and new capital expenditures.

Table 1.

Rankings of the nondurable goods industries, 1964 1/

(Numbers in millions)

Industry rank	Employment		Value added by manufacture		Capital expenditures	
1	Food	1.6	Food	$23,054	CHEMICALS	$1,876
2	Apparel	1.3	CHEMICALS	19,133	Food	1,419
3	Printing	0.9	Printing	11,065	Paper	886
4	Textiles	0.9	Apparel	8,150	Textiles	492
5	CHEMICALS	0.7	Paper	7,805	Printing	463
6	Paper	0.6	Textiles	6,736	Petroleum/ coal	412
7	Rubber/ plastics	0.4	Rubber/ plastics	4,984	Rubber/ plastics	400
8	Leather	0.3	Petroleum/ coal	3,774	Apparel	124
9	Petroleum/ coal	0.1	Leather	2,270	Tobacco	59
10	Tobacco	0.08	Tobacco	1,772	Leather	38
	SYNTHETIC FIBERS NONCELLULOSIC	.04	SYNTHETIC FIBERS NONCELLULOSIC	1,044	SYNTHETIC FIBERS NONCELLULOSIC	164

1/ Source: 1964 Annual Survey of Manufactures, U.S. Department of Commerce.

Of significance, this segment of the synthetic fiber industry accounted for 8.7 percent of the total chemical industry's new capital expenditures--an amount which exceeded the expenditures of the apparel, tobacco, and leather industries. Actual 1964 employment of 44,318 produced shipments in excess of $1,580 million.

Products and Markets

The three major categories of man-made fibers claimed a 1964 domestic output of 3.1 billion pounds, almost half the nation's total output of all fibers. This production broke down as follows:

	Pounds (billions)
Cellulosics (rayon, acetate, etc.)	1.43
Noncellulosics	1.40
Textile glass fiber	.24

It is particularly noteworthy that both value added by manufacture and value of shipments for the noncellulosic category were approximately double the amounts recorded for cellulosic production.

Noncellulosic fibers can be further broken down into three major categories. Estimated production in 1965 rose to 1.68 billion pounds with sales revenues of over $2 billion. Based on output, production was spread among the three categories as indicated:

	Percent of total
Nylons	55.4
Polyesters	22.6
Acrylics	22.0
	100.0

Apparel ranks as the largest consumer of man-made fibers accounting for 43 percent of total sales. Home furnishings and industrial consumption follow with 25.3 and 17.5 percent, respectively, while the remainder goes to miscellaneous uses and exports.

Based on the geographic origin of textile mill shipments, the 8-state South Atlantic sector accounts for over 50 percent of the textile market. When combined with the Middle Atlantic and New England divisions, the figure approaches 78 percent. These figures are equally significant for both the apparel and the home furnishings markets, the latter encompassing draperies, carpeting, and fabric in the main, and is the fastest growing outlet for synthetic fibers.

Plant Ownership and Size Structure

One or more of the noncellulosic fibers is produced by 56 companies which operate over 100 facilities at 82 locations. The leading company controls an estimated 50 percent of domestic capacity, and accounted for over one billion pounds of textile fiber on the worldwide market. Although substantially diversified, fibers claimed 36 percent of the corporation's 1965 sales revenues.

As measured by the Bureau of Census, close to 80 percent of the industry's plants have more than 500 employees and fully one-half employ over 1,000. The economics of large-scale production is of continuing importance to the industry as witnessed by recent developments in Anderson and Greenville, South Carolina.

Geographic Prevalence

Individual plant locations may contain one or more facilities for the production of noncellulosic fibers. As might be expected, the 82 domestic locations are heavily concentrated in the 3 eastern census districts. Capacity rankings of the states for individual fibers are as follows:

Acrylics:	Alabama, Virginia and South Carolina
Nylon:	Virginia, Florida and Tennessee
Polyesters:	Tennessee, North Carolina and South Carolina
Polyolefins:	Virginia and South Carolina
Spandex:	Virginia
Polyinylidene Chloride:	Virginia and Michigan
Polyvinyl Chloride:	Pennsylvania and South Carolina
Fluorocarbon:	Virginia

The South and Middle Atlantic sectors combine to cover 69.4 percent of the establishments, and the addition of New England provides another 15.9 percent. Actual locations, by state, are reflected in the following table:

Table 2.

Noncellulosic fiber manufacture by state 1/

State	Number of Plants
South Carolina	11
Virginia	10
North Carolina	9
Pennsylvania	7
Tennessee	6
New Jersey	6
Rhode Island	6
New York	5
Massachusetts	5
West Virginia	3
Florida	3
Alabama	2
Delaware	2
Maryland	1
Vermont	1
New Hampshire	1
Michigan	1
Ohio	1
Missouri	1
Iowa	1
Total	82

1/ Source: Directory of Chemical Producers, Stanford Research Institute

Appalachian Specialization

Due to its strategic position in relation to textile markets, Appalachian specialization in noncellulosic production runs rather high, with 20.7 percent of the nation's plants located within the Region. Tennessee leads with 5 plants. Pennsylvania, West Virginia, and South Carolina follow with 3 plants, and the Appalachian sectors of New York, North Carolina, and Alabama each claim a single location.

Consideration of the Appalachian fringe areas presents a considerably more dramatic picture. The 12 states of the Region combine to claim no less than 54 plants--over 65 percent of the total U.S. establishments.

Economic Impact

The chemical and allied products industries created 2.2 percent of the total national income and 18.8 percent of the national income originating in nondurable manufacturing, as determined from the U.S. National Income and Product Accounts for 1965. Also in that year, production of synthetic fibers (cellulosic and noncellulosic) involved approximately 102,200 employees. The 72,400 production workers earned in excess of $412 million, with average earnings 15.2 percent greater than the overall nondurable average.

A further indication of the industry's impact can be derived from analysis of the interindustry (input-output) tables. Purchases from direct suppliers are related to $1,000 of plastic and synthetic materials gross output in Table 3. Moreover, every additional direct employee will create 2.8 new positions in supporting industries.

Significantly, a new plant employing 1,000 production workers will disburse an hourly payroll of $5.7 million annually. Using a conservative factor of 3 for the economic velocity, the overall impact on the community would exceed $17 million, without consideration of added supporting (indirect) employment.

Man-made fiber plants, particularly noncellulosics, tend to attract facilities for the production of chemical intermediates. Nylon salts can be produced efficiently and inexpensively in conjunction with the extrusion of the fiber. Similar situations are found in polyester and acrylic fibers. A case in point is the addition of terephthalic acid and dimethyl terephthalate facilities in Kingsport, Tennessee, designed to serve a polyester fiber plant in that city.

Table 3.

Direct requirements per $1,000 gross output 1/

(Producers' prices, 1958 dollars)

Purchases from other establishments	Plastic & synthetic materials
Coal mining	$ 5.37
Maintenance & repair construction	6.20
Stone & clay mining & quarrying	-
Lumber & wood products, except containers	-
Wooden containers	-
Paper & allied products, except containers	45.24
Paperboard container & boxes	5.50
Chemical & selected chemical products	340.87
Plastics & synthetic materials	26.82
Drugs, cleaning & toilet preparation	10.62
Paints & allied products	6.20
Petroleum refining & related industries	13.00
Rubber & miscellaneous plastics products	17.62
Glass & glass products	-
Stone & clay products	-
Transportation & warehousing	30.70
Electric, gas, water & sanitary services	9.55
Wholesale & retail trade	19.66
Finance & insurance	7.01
Retail estate & rental	5.74
Business service	12.57
Gross imports of goods & services	8.38
Business travel	-
Other industries	34.29
Total purchases	605.34
Value added	394.66
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Consumption

Currently, the industry is operating at 87 percent of rated capacity, and virtually all sectors are growing at a rapid rate. There is little doubt in the minds of most chemical company executives that the growth will continue; however, some have begun to express fears of over-capacity.

Consumption projections for the next 5 to 7 years are reflected in the following consensus of industry opinion.

	Projected annual growth rate (percent)
Noncellulosic fibers	10-11
Noncellulosic yarn	14
Noncellulosic staple	20
Nylon fibers	8-12
Nylon filament yarn	7
Acrylic fibers	8-10
Polyester fibers	15-25
Polyolefin fibers	18
Polypropylene fibers	20-30
Spandex fibers	15-30

A 37 percent increase in industry capacity is anticipated by the end of 1968.

Profits

Pre-tax fiber earnings have not kept pace with the rapid gain in consumption over the past 10 years, as the industry experienced price reductions of 19 percent for textile fibers and 44 percent on fibers used in industrial applications. However, the industry's leader derives over one-half its profits from synthetic fibers and boasts a 1965 ratio of 13.5 percent net profits to net sales. Similar figures for other leading firms vary from 3.9 percent to 11.0 percent. All of these industry giants are substantially diversified, producing in many areas of the chemical field.

Employment

On the whole, synthetic fiber employment has increased some 55 percent since 1958. Bureau of Labor Statistics data is reflected in Table 4 for the combined cellulosic and noncellulosic industries. It is estimated that the latter accounts for about 58 percent of the total.

Planned and projected capacity increases will continue the growth in employment evidenced over the past years.

Table 4.

Employment in the synthetic fiber industry 1/

Year	All employees	Women employees	Production workers	Average weekly
1958	66.1	-	47.0	39.9
1959	68.7	17.0	49.8	40.8
1960	70.8	16.9	50.4	40.7
1961	71.0	17.3	50.2	41.0
1962	76.7	19.1	55.0	41.4
1963	82.0	19.7	57.7	41.3
1964	88.1	21.3	62.2	41.9
1965	102.2	24.5	72.4	41.2

1/ Source: Employment and Earnings - Establishment Data, Bureau of Labor Statistics

Investment and Locational Activity

Major producers of the industry were spending at the rate of $170 million annually during 1963 and 1964, as indicated in Bureau of Census statistics. Two companies alone appropriated over $85 million in 1965. Projections call for an increase in capacity between 1966 and 1970 amounting to just over 40 percent, giving rise to even greater expenditures in the relatively near future.

Locational activity in the Appalachian Region is compared with the total U.S., between 1958 and 1963, in Table 5. While both areas were growing rapidly, Appalachia took the edge by doubling its industry population.

Table 5.

Locational activity for the noncellulosic synthetic fiber industry 1/
(Net change)

	Establishments	
	Total U.S.	Appalachian Region
1963	25	6
1958	14	3
Net increase (decrease)	11	3
Percent change	78.6	100.0

1/ Source: 1963 Census of Manufactures

Activity in the industry during the past 3 years has been even greater. New plants and expansions are playing a relatively equal role in the rapid increase in capacity. No less than 15 new plants and 12 expansions have been completed, announced, or are currently under construction. This activity remains concentrated in or around Appalachia, with South Carolina, Tennessee, North Carolina and Virginia claiming the major portion. Significantly, the 2 projects mentioned earlier for Anderson and Spartanburg, South Carolina will provide employment for over 2,000 people.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Production processes are quite similar in both old and new plants. Syrup, made up from the various chemical inputs, is forced through the tiny holes in a device called a spinneret; filaments emerge and are allowed to harden. The process is called spinning although it differs greatly from the textile operation of the same name which converts short fibers into yarns. The latter applies to synthetic fibers when filaments are cut into short pieces called staple, which is then spun into yarn.

Filament yarns may have one strand or several, and tend to be shiny and hard. The softness and appearance of spun yarns are added by crushing, crimping, bending, or otherwise "texturing" chemically or mechanically. The syrup accounts for the differences among the various fibers.

While basic production technology is not expected to undergo any radical change, continued research and development efforts will turn out new fiber chemistry and texturing processes.

Raw Materials

The raw materials required for various types of fibers are indicated in Table 6. Trends within the industry are characterized by the search for new, cheaper substitutes for both primary raw materials and intermediates. In 1965, terephthalic acid became commercially available as a substitute for dimethyl terephthalate in the production of the fast-growing polyesters. Meanwhile, an industry leader moved toward more economical production of nylon by converting acrylonitrile (the basic ingredient of acrylic) into adiponitrile (a basic ingredient of nylon).

Table 6.

Raw materials required in the production of noncellulosic synthetic fibers 1/

Fiber	Primary raw materials and intermediates
Polyamide	
Nylon 6	Caprolactam from cyclohexane, or from phenol-hydroxylamine
Nylon 7	Pelargonic acid
Nylon 11	11-amino undecanoic acid derived from castor oil
Nylon 12	Laurolactam (azacyclotridecan-2-one) made from cyclodecatriene or from a 7-step synthesis starting with butadiene
Noylon 6/6	Adipic acid from cyclohexane and hexamethylene diamine from adiponitrile
Acrylics	Acrylonitrile with various modifying agents, such as vinylenlonde methylacrylamide vinyl pyridine, vinylidenechloride, etc.
Polyesters	Dimethyl terephthalate or tergphthalic acid from p-xylene and ethylene glycol, with various modifying agents such as vinyl acetate
Polyolefins	Polyprophlene or copolymers, also tetrafluoroethylene
Spandex	Polyurethane from isocyantes and polyethers
Vinyl and vinylidene chloride	Vinylacetate, vinyl chloride, vinyl alcohol and vinylidene chloride
Dinitrile	Vinylacetate, vinylchloride, vinylidene cyanide

1/ Source: Compiled by Fantus Area Research from various sources

The development of new fibers and fiber families will be based on the chemistry of both raw materials and intermediates.

Manpower Utilization

Consolidated data for cellulosic and noncellulosic fiber production demonstrates an average annual productivity increase of 4.4 percent between 1957 and 1963. Comparable figures, related strictly to production workers, reflect an average increase of 4.6 percent. The production of cellulosic fibers saw a decrease of 28.6 percent in total employment between 1958 and 1963, with a concurrent 5 percent increase in the production worker ratio. This loss was more than compensated by a 121.7 percent increase in noncellulosic production, resulting in a net increase of 10,000 workers during the 5-year period.

The ratio of females in the industry varies directly with the extent of a plant's integration into textile type operations. This number runs between 10 and 35 percent with the "typical" unit employing around 15 percent females.

Skilled employees make up a high proportion of the work force, although many of these skills are developed through in-plant training and the textile operations can normally be taught rather quickly to people of average intelligence.

Since the industry itself is relatively new, most production capacity is similarly modern and efficient. In general, the process end of the operation leaves little room for improved manpower utilization. However, more automated machinery, textile and materials handling operations, and increased use of computerized process control all hold out potential for improving overall productivity. Heavy maintenance skill requirements will persist.

Interproduct Competition

Man-made fibers not only compete among themselves but also with natural fibers in virtually all marketing outlets. Some specific fibers compete in all of the markets while others exhibit properties which are valued more highly in specific end uses. Typical of the latter are the wool-like properties of the acrylics, which find their major outlet in knitwear, blankets, better grade carpets, and other markets formerly dominated by wool. Spandex holds a unique position in the burgeoning market for stretch fabrics in addition to ladies' foundation garments. Special purpose carpets, such as the new indoor-outdoor variety, rely on the polyesters.

Price considerations remain a major factor in the interproduct competition. However, extensive brand association derived through national advertising, raw material positions, world-wide patent positions, service consideration as well as various other tangible and intangible factors affect a fiber's ultimate penetration of the market.

Distribution

Synthetic fibers are distributed primarily through company sales representatives, although some are handled by jobbers. Long-term contractual commitments are not the rule. In most plants, however, 35 to 40 percent of the customers account for over 90 percent of production.

Shipments are almost exclusively by common carrier trucking operations with less than 25 percent involving LTL quantities. Synthetic fiber staple is the only product utilizing rail movements to any appreciable degree. All shipments move directly to the customer and warehousing is virtually nonexistent. At least one major producer serves the national market from an Appalachian location; however, the majority of its output goes to markets east of the Mississippi.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

New noncellulosic organic fiber plants present an extensive set of locational criteria. Overall market orientation plays a key role in the establishment of a new facility. In addition, locations must satisfy the following:

(1) large acreage sites with adequate surface and ground water;

(2) a suitable (and abundant) labor supply, wage pattern and industrial relations history;

(3) minimum total freight costs and inventory requirements;

(4) economical fuel and power; and

(5) a tax climate conducive to long-term operations.

The importance of individual factors varies with the particular objectives of a location seeking company as well as the actual fiber(s) to be produced.

A trend to shortening supply lines for raw materials has become apparent and is designed to solidify a raw materials position while minimizing transportation costs. In most cases, this has involved the addition of raw material capacity on or near the fiber plant site.

Market Orientation

Historically, manufacturers have been drawn to areas with overnight to second-day delivery to the principal style centers of the Northeast and the heart of the textile industry in the Southeast. A progressively shortening style cycle, highlighted by women's apparel, has meant a large premium for those firms positioned to assure fast delivery.

As with other market-oriented industries, this factor serves to prescribe only the broad geographic boundaries of the locational search. Within these limitations, precise locations will depend on a least-cost analysis of areas which satisfy the primary locational factors in a manner that provides for fulfillment of long-term operating objectives.

Site Requirements

Today's new fiber complex requires water sites of 300 to 700 acres, with a minimum of 75 to 250 usable acres. Plants producing the modern fibers utilize water primarily in cooling, and effluents present neither a BOD (Biochemical Oxygen Demand) nor a metallic ion problem. Waste treatment facilities are relatively simple and usually require only ponding arrangements.

Ideally, sites will involve a minimum of preparation costs and freedom from flooding is of paramount importance. As noted later, locations on navigable waterways will be most attractive.

Labor Supply

Plants employing over 1,000 workers characterize the noncellulosic synthetic fiber industry. Leading producers insist on a minimum of 2 years' high school education and internally train most skills. Cut-off scores of 10 or 20 on the Wunderlic Test are common.

Accordingly, labor abundance becomes a prime requirement of the industry. Labor must be available in sufficient numbers to allow for selective hiring. A total potential supply versus demand ratio of 10 to 1 is considered favorable and larger numbers are preferred. Supply calculations include "underemployed" persons with less than $2,500 average annual earnings, as well as the unemployed and new labor force entrants. Demand potential provides for existing industry attrition replacement and known or projected work force expansions.

In general, synthetic fiber plants are the wage leaders in their given area and, thus, enjoy a unique position. Labor shed studies in Southern Appalachia demonstrate the impact of fiber mill employment on commutation patterns. Higher wage fiber plant workers commute considerably farther than lower paid employees, such as those in the apparel industry.

In one study, the labor-shed (or labor market area) was arbitrarily defined as the region encompassing the nearest 90 percent of a plant's labor force. For the fiber plant, this area extends almost twice as far, covering an area about three times larger than a local (large-scale) apparel operation. Workers averaged 17.5 miles or 28.7 minutes in one-way travel. About 37.9 percent lived more than 20 miles from the fiber plant and fully 21 percent traveled over 30 miles. Less than 55 percent had residence within 15 miles of the plant site.

Commuting patterns for different locales are not directly comparable. Differences in degree of urbanization, city size, terrain, road networks, mode of transportation, job opportunities, wage levels, etc. all affect the willingness of workers to travel greater distances.

Labor-sheds will frequently overlap or, in some cases, be completely contained within another, greater labor-shed. Considerations of terrain, including the presence of large bodies of water, and the condition of highway networks have a substantial role in delimiting the actual boundaries. Of significance, boundaries diminish by degree rather than abruptly.

Manning and Skill Requirements

The process nature of the industry together with the high capital investment for plant and equipment dictates continuous around-the-clock operation. Plants operate with 4 shifts which require female participation on each.

Skill requirements range from the unskilled material handling operators up to the highest of sophisticated mechanical and electrical maintenance and chemical plant operators. Emphasis varies with the individual plant's extent of forward and/or backward integration into raw material production or textile operations. In general, the large requirements for maintenance skills are problematical. Machine operators are also required in large numbers, however, adept personnel can usually be trained in 2 to 4 months.

Manning requirements for the typical plant employing 1,500 would break down along the following lines:

	Percent of total labor complement
Technicians	15
Maintenance	10
Skilled	20
Semiskilled	40
Unskilled	10
All others	5

As noted in Section III, female employment can vary between 10 and 35 percent.

Labor Costs

Straight time plant-wide average hourly earnings range from $2.30 to just under $3.00, exclusive of shift premiums. Shift differentials paid by the industry vary from 4 to 10 cents on the second shift and 10 to 15 cents hourly on the third shift and, together with Sunday premiums, can raise the overall plant-wide average by as much as 10 percent. Typical plants in Lower Appalachia exhibit average hourly earnings within the following ranges:

	Average hourly earnings
Mechanic lead man	$3.30-$3.50
Skilled mechanic	3.20- 3.40
Skilled operator	2.70- 3.05
Semiskilled operator	2.30- 2.70
Unskilled labor	1.95- 2.25

The above data compares favorably with the industry's overall average production worker earned rate of approximately $3.00 per hour (including all wage premiums) in 1965.

Fringe benefits also contribute to establishing a rather unique position for the industry. Almost all of the plants carry packages comparable to the more industrialized Northeast and Great Lakes areas, regardless of location. Manufacturers frequently offer 7 to 9 paid holidays, a vacation schedule that escalates up to 3 weeks after 5 years and 6 weeks after 35 years, noncontributory life insurance, health insurance and pension plans and, in some cases, thrift plans which involve company contributions.

These programs substantially exceed the local patterns of most locations. As a result, the industry is in a prime position to attract and hold employees with prior manufacturing experience. The prevailing lower fringes offered by local manufacturers will do little to hold back or "lock-in" experienced employees anxious to increase their earnings.

Unionization and Wage Pressures

As noted earlier, most fiber plants prefer to establish in areas where they are the predominant and wage-leading industry. A large capital investment combines with the competitive nature of the market to demand close attention to a project's economic justification. Labor costs are but one of many factors; however, they are the one which is most sensitive to rapid escalation. Predetermined long range labor cost projections must be achievable if a location is to receive serious consideration.

Major producers operate nonunion, with independent unions, or with national affiliations. It is not uncommon for a single company to have plants in all three categories. Nonetheless, new locational activity will strive to find areas exhibiting labor serenity, and some have a distinct preference for nonunion operations in their new locations. Wage patterns and fringe packages may remain unchanged; however, extremely costly work stoppages and shutdowns are thus avoided.

Transportation

Outbound shipments rely primarily on truck transport with exceptionally long-haul moves utilizing rail. Inbound shipments are predominantly rail, although waterway transportation is becoming increasingly significant.

With other considerations equal, locations providing the lowest total transportation costs will be most attractive. On the whole, these costs can run between 15 and 25 percent of a plant's total annual operating expenditures.

Unfortunately, numerous considerations affect the total picture and preclude any standard treatment from the cost standpoint. The degree of integration included in the facilities, the actual fiber involved, the company's raw material position, and location of major marketing outlets all must be considered. The common locational element is found in the requirement for immediate access to adequate rail and highway services.

Waterway transportation is increasing in importance for inbound shipments. Significant savings can be available under the proper conditions. Moreover, water-compelled rail rates can provide further savings as well as flexibility in service.

Utilities

Utility requirements of man-made noncellulosic fiber plants vary extensively with the type of fiber produced and, once again, the degree of operational integration. However, typical requirements for a plant employing 1,500 workers and producing one of the more modern (polyester) fibers are indicated in the following discussion.

As a group, utility expenses account for roughly 12 to 18 percent of a plant's total operating costs. In addition to their cost import, however, there is a critical requirement for stability of supply. The expense involved in service curtailments can rapidly wipe out the cost benefit of a particular location.

Power

Plants of the nature described above typically would exhibit a total power demand of 8,500 to 10,000 kilowatts. Monthly usage would fall between 4.5 and 5.3 million kilowatt-hours.

Power costs are subject to the wide range of rate structures and can vary by over 70 percent in adjacent service areas. For comparative purposes, the annual power costs of manufacturers located on the TVA system would approximate $470,000 for the above requirements.

Water

Water requirements are split between sanitary (potable) and process makeup. Potable intake will range between 80,000 and 110,000 gallons per day with a similar amount expelled as waste. Process intake primarily goes to boiler feed makeup and cooling purposes and can require as much as 1.5 million gallons per day if the plant does not use a closed-loop cooling system. For process purposes, the raw water analysis preferably should fall below the following maxima:

Hardness	100 ppm as $CaCO_3$
Calcium	90 ppm
Magnesium	30 ppm
Alkalinity	50 ppm
Chloride	75 ppm
Sulphate	75 ppm
Silica	10 ppm as SiO_2
Iron	0.1 ppm as Fe
pH	7-7.5 pH factor
Turbidity	5 scale
Color	5 scale

Fuel

Process and heating requirements for steam typically would involve the generation of 75,000 to 85,000 pounds per hour. Using the midpoint, steam generation is translated into a fuel requirement of 2,137 million Btu's per day. Thus, plants of this size must purchase roughly 14,000 gallons of fuel oil, 2.14 million cubic feet of natural gas fuel, or over 790 tons of coal for each day of operation. While all three fuels find their place in the economics of plant location, recent experience indicates a tendency toward gas with coal and oil following in that order.

State and Local Tax Climate

New man-made fiber plants involve an investment normally ranging between $25 and $50 million. Accordingly, firms seeking new locations will avoid, if possible, those areas where machinery and equipment are taxable by local authorities. Communities where local taxes are restricted to assessments on real estate will be most attractive. Tax considerations are somewhat more elastic than previously mentioned locational criteria; however, locales exhibiting a high degree of tax stability will be most suitable for long-term operations.

Financing

Due to the size of investment required, the industry is essentially comprised of large and financially stable, diversified companies. Many of these companies are anxious to partake of the advantages offered by revenue bond financing and will express this as one of the more flexible locational determinants.

Community and Environment

Large labor requirements and other labor objectives lead most establishments to the outskirts of communities with 25,000 to 40,000 population. New plants will search out areas where they can retain a prominent position and thus frequently gravitate to the lower end of the scale.

The sophisticated operations of a process-type industry require a large technical complement and normally involve the relocation of numerous company supervisory personnel. Thus, communities must provide an environment which is attractive to the families of transferees and will assist in the attraction and retention of professional personnel. Nearby access to higher education will be an asset as will both cultural and recreational amenities and an above average school system.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

The extensive set of almost equally important locational criteria provides many areas for effective public investment. Vocational training, improved transportation facilities, power requirements, provisions for natural gas service, river basin management, and community improvement programs all are worthy of consideration.

This section of the report places emphasis on those public activities and investments which will be most effective in influencing the expansion of the existing industry and attracting new locational activity. The suggestions included herein are oriented to improving the position of the entire Appalachian Region without regard to the specific situation of individual communities or areas. Obviously, many of these areas can already satisfy the primary requirements of the man-made fiber industry.

Vocational Training

The initial training costs of a plant employing 1,500 workers would run in excess of $1 million--a significant amount regardless of the sizable initial investment. No executive expects to find a ready-made skilled work force. However, a locale providing a labor reservoir which is educated in the basics of industry will retain a definite advantage. Training facilities and assistance which can quickly adapt to the initial requirements of plant operation will hold out the attractive potential of reduced start-up expenses. Financial assistance for in-plant training will be equally beneficial.

Course offerings designed to induce new fiber plant locations will emphasize mechanical and electrical maintenance skills, including welding, machine design and repair, machine shop operations, blueprint reading, electrical apparatus repair, and electrical wiring theory and practice. More general courses for less adept people should provide the basic mechanical knowledge necessary to facilitate rapid assumption of machine operator positions.

Transportation

Noncellulosic synthetic fiber plants cannot exist without adequate highway and rail transportation. Rail is used primarily for inbound shipments, and areas which are otherwise suitable will be eliminated if service is not within economical reach.

Highways find a twofold importance. First, is the predominant reliance on truck transport for outbound shipments. Secondly, the large work force requirement necessitates extended commutation patterns. The latter points out the need for adequate feeder systems surrounding communities of 25 to 40 thousand population. The willingness of workers to travel longer distances is substantially affected by both the existence and condition of the highway network. Completion of proposed primary highway corridors will facilitate outbound shipments and is certain to open new areas of Appalachia to consideration by the industry.

Waterway transportation is growing in importance to the industry. Manufacturers are realizing new economies on inbound shipments, and prefer the resulting flexibility of an alternate mode of transportation. Water-compelled rail rates provide a significant added benefit.

While not yet a primary locational factor, the availability of waterway transportation is considered a large asset in the locational decision.

Power

As indicated in Section IV, power costs can vary between $470,000 and over $800,000 annually for a plant employing 1,500 workers. The lower rate was calculated from published TVA rates and points up the advantage available to manufacturers located on that system. Similar programs or actions designed to establish a rate structure competitive with TVA are certain to attract the attention of synthetic fiber producers.

Natural Gas

The requirement for natural gas is more flexible than the demands on transportation and power. Substitute fuels have been economically utilized in the past. However, there is a noticeable preference for natural gas fuel in new plant locations. Public action designed to provide this service would be effective if directed to areas that otherwise satisfy the primary locational needs of the industry.

River Basin Management

River basin management provides another general area of effective public investment. Flood-free sites are a prime requirement of the industry. Process and cooling water requiring minimum treatment reduces the initial capital investment.

Community Improvement

As noted in Section IV, community and recreation amenities play a distinct, although somewhat secondary role in establishing new synthetic fiber plants. Community appearance, local living conditions, and the quality of the local school system are of equal importance. The availability of cultural and recreational facilities follows close behind. Access to higher education will prove an asset.

Federal and state programs cannot be expected to change a community's complexion overnight. Moreover, the effect of even total reconstruction will rapidly disappear if both the desire and the willingness to work for improvement is not ingrained in the spirit of the community. Accordingly, it is suggested that improvements be effected through "self-help" programs designed to motivate the community to action. Consultation from government agencies can ensure proper community planning. Federal housing programs provide the answer to unsightly slum areas. However, the residents and merchants of the area can produce the most immediate effect. A progressive community would be best. A progressing community is next best.

Appendix A

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(6) Labor union contracts.

(7) Industry trade associations.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 14--THE METAL STAMPINGS INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such industry, specifically Standard Industrial Classification industry code 3461, Metal Stampings.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

An industry approaching $3 billion in annual sales, with markets surrounding its location, should certainly have ample opportunity to profitably operate within Appalachia. Public policies that will encourage metal stamping companies to locate in Appalachia include: improved highways to these markets, occupation-centered vocational training, higher standards of basic education, and low-capital financing guarantees.

The industrialization of areas in proximity to Appalachia have created markets for industrial parts manufactured by the metal stamping industry. Appalachia's orientation to this blossoming market is ideal. Raw materials can readily be supplied from major steel centers located at either end of the Appalachian Region.

Also available in Appalachia is a labor pool readily adapted to a wide variety of repetitive operations common to the metal stamping industry. Average earnings of $6400 in the industry would contribute to the economic well-being of a large portion of the labor force.

Many location factors necessary to attract the metal stampings industry are already present in Appalachia. Public investment in occupation-centered vocational training curricula will aid in the staffing of new plants.

To attain immediate location goals, however, public investment should first concentrate on access to the existing industrial markets on the periphery of Appalachia. Major corridors and secondary highways will enhance the market penetration of metal stamping firms locating in Appalachia.

Improved educational standards in many areas of Appalachia will contribute to larger pools of trainable manpower for the more sophisticated, and higher paying, mechanical skills required in the metal stamping industry.

Job opportunities thrive on new business starts. Entrepreneurs with well-founded products need encouragement to start their own business through government guaranteed loans.

Ramifications of these and other locational determinants are outlined herein.

I. PROFILE OF THE INDUSTRY

Size

There are over 3,000 establishments in the U.S. producing metal stampings along with other products. That is about the same number of manufacturing establishments as found in the states of Alabama or Virginia. Of this number, 623 establishments employ more than 50 people and 37 of these establishments are located within Appalachia.

The 1963 Census of Manufactures statistics are based upon those firms whose primary production is in metal job stamping and finished end products. Establishments primarily producing metal stampings number 2,574 and create a value added of $1.4 billion dollars. These establishments generally operate on a job or order basis, manufacturing metal stampings for sale to others or for interplant transfer. Establishments which produce metal stampings for incorporation in end products produced in the same establishments are classified on the basis of the end products. Many plants which engage in this type of metalworking are classified under other industry categories, e.g., automotive parts, appliance parts, office machinery parts, textile machinery parts, aerospace contract work, and metal furniture parts. Therefore, in measuring the metal stampings industry (SIC 3461), interpretation of all statistics from the Census and Survey of Manufactures must be regarded as relative, but not absolute.

When measured beside the durable goods industry, as in Table 1, metal stampings reflect their industry size as a parts contributor to products represented by each of the other categories. Stampings are used as parts in transportation equipment, general and electrical machinery, fabricated metals, furniture, instruments, and ordnance.

Although the value added in the metal stampings industry is less than half that of the furniture or ordnance industry, it is improving its productive capacity by spending almost 40 percent more in 1966 for new plants and equipment. This indicator of automation is a definite trend in the stampings industry.

Table 1.

Rankings of the durable goods industries 1/

(Numbers in millions)

Industry rank	Employment		Value of shipments	
	TOTAL	9.199	TOTAL	$ 232,170
1	Transportation Equipment	1.624	Transportation Equipment	57,846
2	Machinery	1.537	Primary Metals	40,036
3	Electrical Machinery	1.483	Machinery	34,219
4	Primary Metals	1.179	Electrical Machinery	31,054
5	Fabricated Metals	1.116	Fabricated Metals	24,877
6	Stone, Clay, & Glass	.581	Stone, Clay, & Glass	12,973
7	Lumber & Wood	.562	Lumber & Wood	9,885
8	Furniture	.386	Instruments	6,616
9	Instruments	.309	Furniture	6,302
10	Ordnance	.234	Ordnance	4,421
11	Metal Stampings	.137	Metal Stampings	2,889

Industry rank	Capital expenditures		Value added by manufacture	
	TOTAL	$7,130	TOTAL	$ 115,744
1	Primary Metals	1,887	Transportation Equipment	23,961
2	Transportation Equipment	1,297	Machinery	19,762
3	Machinery	946	Electrical Machinery	18,039
4	Electrical Machinery	889	Primary Metals	16,732
5	Fabricated Metals	728	Fabricated Metals	12,636
6	Stone, Clay, & Glass	626	Stone, Clay, & Glass	7,520
7	Lumber & Wood	369	Lumber & Wood	4,361
8	Instruments	165	Instruments	4,333
9	Metal Stampings	156	Furniture	3,225
10	Ordnance	117	Ordnance	2,871
11	Furniture	106	Metal Stampings	1,368

1/ Source: 1964 Annual Survey of Manufactures

Products and Markets

The $2.9 billion value of shipments for 1964 are very noticeably dominated by the job stamping sector for both automotive and nonautomotive parts. Table 2 relates the subindustries of the metal stamping industry and shows $1.8 billion of the $2.9 billion is in job stamping.

Table 2.

Industry shipments by production segment 1/

(Percentages based on dollar value)

SIC	Classification	Dollar value of shipments 2/	Shipments % of total
3461	Metal Stampings	2,740	100
34613	Job Stampings, Automotive	953	36.1
34612	Job Stampings, except Automotive	858	32.5
34618	Other Metal Stampings	274	10.0
34616	Metal Commercial Closures, except crowns	158	6.0
34615	Other than Aluminum, Stamped and Spun Utensils, Cooking, Kitchen and Hospital	123	4.7
34614	Aluminum, Stamped and Spun Utensils, Cooking, Kitchen and Hospital	116	4.4
34617	Crown (Bottle Caps)	86	3.2
34611	Vitreous Enameled Products	81	3.1

1/ Source: 1964 Annual Survey of Manufactures

The great variety of unrelated end use products of the industry ranges from pots and pans to bottle caps. A substantial volume of job stamping is devoted to airframes and aircraft surfaces. Other products include lids for fibre drums, metal shelving, electronic casings, office machinery casings, furniture reinforcements, housings for light fixtures, appliance cabinets, and building partitions. Consumer products are represented by cookware, hospital utensils, pails, ashcans, and vitreous enameled products.

Sales to other manufacturing establishments represent the most important market in the industry. Job stampings are made from materials owned by the stamping establishment as well as from materials owned by the customer and processed on a contract or commission basis. A large but immeasurable portion of metal stampings are manufactured as intracompany transfers as well as interindustry transfers.

Plant Ownership and Size Structure

Total sales for even the largest firms that are predominantly in metal stampings do not exceed $170 million each. The great majority of firms are job shops employing less than 50 employees. In fact, the 1963 Census of Manufactures shows that 57 percent of the U.S. establishments in this industry each employs less than 19 persons. What might be described as a "typical shop" would be family-owned, or a partnership, with a small investment in plant and equipment. The factory might contain a battery of 10 to 20 presses each set up for a series of step operations in blanking, cupping, drawing, and trimming. One to fifty job lots for several customers may be within the plant at one time.

Exceptions to ownership size are found in the subindustry of cooking utensils. Owned and operated as comparatively minor divisions of large aluminum and copper producers, these operations are highly competitive, mass-produced, and marketed chiefly through retail stores for the domestic consumer.

Geographic Prevalence

The industry tends to cluster around other metalworking establishments--their customers for the most part. Statistics in Table 3 show that the East North Central and Middle Atlantic states have the greatest number of metal stamping establishments. The metal stamping industry is spread through 44 states, with 25 states having 10 or more establishments. According to the 1963 Census of Manufacturers, Michigan's $382 million leads in the value of shipments for the industry, followed by Ohio ($361 million), Illinois ($334 million), Pennsylvania ($324 million), and New York ($207 million). Pennsylvania's 56 plants represent nearly one-half of the Appalachian count of 118.

Market-oriented to the automotive, appliance, and electrical machinery industries, the metal stamping companies stand close by their customers for sales, design and specification changes. In effect, they are subject to the make-or-buy decisions of larger firms who cannot efficiently set up for short runs, or customers who may not have the required technical skills to perform the operation and do not have long runs that would justify hiring the skills.

Table 3.
Metal stampings industry
regional distribution of establishments 1/

Geographic area	SIC 3461
New England	
Total	257
Employing over 50	48
Middle Atlantic	
Total	629
Employing over 50	128
South Atlantic	
Total	74
Employing over 50	21
East North Central	
Total	1112
Employing over 50	283
East South Central	
Total	56
Employing over 50	20
West North Central	
Total	108
Employing over 50	28
West South Central	
Total	47
Employing over 50	7
Mountain	
Total	13
Employing over 50	-
Pacific	
Total	278
Employing over 50	28
UNITED STATES	
TOTAL	2574
EMPLOYING OVER 50	563

1/ Source: 1963 Census of Manufactures

The exceptions to the job shop operations are the producers of cooking utensils. This highly competitive sub-industry is consumer market-oriented and has recently initiated a trend to regional warehouses. A major plant producing cooking utensils is located within Appalachia at Chillicothe, Ohio. A mass production assembly line operation for standardized products is the rule here.

Table 4.

Metal stampings
establishments within the Appalachian Region 1/

	SIC 3461	
State	Total	Employ Over 50
New York	19	9
Pennsylvania	56	19
Maryland	-	-
Virginia	-	-
West Virginia	10	4
Ohio	6	5
North Carolina	2	-
South Carolina	2	2
Georgia	4	2
Kentucky	1	1
Tennessee	9	5
Alabama	9	3
TOTAL	118	50

1/ Source: 1963 Census of Manufactures

Economic Impact

Wages and salaries create the greatest economic impact. Department of Labor Statistics counted 198,000 employees in 1964, and 220,000 in June of 1965, a remarkable growth. Average annual earnings of $6,400 for production workers is higher than that of the durable goods industry as a whole, which was at $5,980 in 1964.

Payments for goods and services generate flow to the primary metal centers for raw stock used in the metal stampings. Table 5 represents a proportioned accounting for each $1,000 of gross product.

Because the metal suppliers hold the heavier hand in this customer-supplier situation, the small metal stamping plant would not attract metal distribution warehouses. A large metal stamping producer in the field could attract metal warehousing operations. In the last five years this attraction for satellite industries has occurred near Atlanta, Georgia, Greenville, South Carolina, and Charlotte, North Carolina.

Table 5.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

	Purchases from other establishments	Stampings, Screw Machine Products & Bolts
20	Lumber & wood products, except containers	$ 5.09
25	Paperboard containers & boxes	9.16
31	Petroleum refining & related industries	6.33
32	Rubber & miscellaneous plastic products	6.53
36	Stone & clay products	7.73
37	Primary iron & steel manufacturing	199.12
38	Primary nonferrous metals manufacturing	64.77
40	Heating, plumbing & structural metal products	7.92
41	Stamping screw machine products & bolts	40.22
42	Other fabricated metal products	26.39
47	Metalworking machinery & equipment	11.35
59	Motor vehicles & equipment	26.39
64	Miscellaneous manufacturing	5.05
65	Transportation & warehousing	15.85
68	Electric, gas, water & sanitary services	8.90
69	Wholesale & retail trade	29.66
70	Finance & insurance	7.95
71	Real estate & rental	8.35
73	Business services	9.13
80	Gross imports of goods & services	5.98
81	Business travel, entertainment & gifts	10.06
	Other industries	48.70
	Total Purchases	560.63
	Value Added	439.37
	TOTAL	$ 1,000.00

1/ Source: September 1965, Survey of Current Business

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Sales

When measured by the value added by manufacture, Census statistics show a growth of 37 percent between 1958 and 1963. An annual rate of 8 percent growth was stimulated between 1963 and 1964.

More than 80 percent of this industry's production is derived demand from other industries, particularly that of the automotive industry. The automobile industry has doubled its production in eight years. Sales have climbed steadily in recent years as follows: 7 million in 1962, 7.7 million in 1963, 8.1 million in 1964, and 8.2 million in 1965.

Expenditures for automobiles and parts usually correlate to personal disposable income in the U.S. In 1965, 6-1/2 percent of this disposable income was spent on automobiles and parts. There is a similar correlation with the record volume of personal consumption expenditure for other durable goods that will reach $4.6 billion in 1966, an increase of 5.6 percent from 1965. Household appliances, kitchen utensils, and garden equipment are some of the products attracting these dollars. An expected rise in new family formations, continuing expansion of disposable income, and demographic patterns insure very high expenditures in the future for domestic durable goods. The impact on the metal stampings industry will follow this demand.

Government expenditures for aircraft and ordnance materials will strain the capacity for large sectors of the metal stamping industry. Aircraft, aerospace, surface vehicles, ammunition cartridges, and even mess hall trays represent some of the product demand that will cause industry growth for the immediate future.

Major airframe manufacturers that now are producing 80 percent for the military anticipate a 70 percent ratio by 1968, as new giant commercial transport orders roll in. One of the largest airframe contractors is located on the southern fringe of Appalachia, which in itself could portend long range growth for the metal stamping industry.

Profits

Net profit ratios as a percentage of sales in the metal stampings industry portray a lower range than found in other metalworking industries. Table 6 provides a comparison with two other industries. The 112 reporting companies in the metal stampings industry had a net profit on sales median of 3.76 percent in 1964. On the other hand, the 115 machine shops reporting to Dun & Bradstreet's 1964 survey had a median of 4.52 percent.

Table 6.

Profit ratios in the metalworking industry 1964 1/

	SIC 3461 Metal stampings (112)	SIC 354 Metalworking machinery (102)	SIC 359 Machine shops (115)
Net profits, percent			
On sales	5.86	6.70	7.22
	3.76	3.87	4.52
	2.47	2.36	2.42
On tangible net worth	18.66	15.79	22.20
	12.61	8.81	15.71
	7.22	5.16	8.37
On net working capital	40.16	29.08	59.07
	20.69	16.86	30.32
	11.67	9.88	13.37

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc.

The net profits on tangible net worth are being used increasingly as a final criterion of profitability. Generally, a relationship of at least 10 percent is regarded as a desirable objective for providing dividends to owners plus funds for future growth. According to figures in Table 6, the metal stampings firms represented by the Dun & Bradstreet survey are more profitable than the metalworking machinery firms, but less profitable than the machine shops.

What these percentages do not show is volume and velocity of the sales dollar. It is more profitable to sell $10 million at a 1 percent return on sales than it is to sell only $1 million at a 6 percent return on sales ($100,000 versus $60,000).

As an example of volume relationships, 4 major metal stamping firms grossing over $100 million each in 1965 had an average net profit on sales percentage of 3.4; and yet 4 $5 million to $10 million firms studied averaged a 6.7 percent net profit on sales.

Typical job shops minimize their losses during very slack periods by accepting contracts below the normal rate of return. This has not been the case since 1961 as "optimum operating capacity has been maintained", according to one industrialist.

Employment

Growth trends in employment for the metal stampings industry are shown in Table 7. In five years, productivity per employee rose 24 percent, from $8,341 in 1958 to $10,357 in 1963 (adjusted to 1958 dollars).

Automation of stamping machines and auxiliary feeds are attributed to this increase in productivity. Trends to greater automation have ample opportunity to increase, as obsolete machinery and more innovations are introduced. The value and skill of the machine operator should keep pace with this trend in productivity.

Table 7

Employment in the metal stampings industry (SIC 3461) 1/

Year	All employees (1,000)	Production workers (1,000)	Women employees (1,000)	Production workers average weekly hours
1958	171.2	134.1	35.5	40.0
1959	188.4	152.8	34.4	41.9
1960	195.4	158.9	32.0	41.6
1961	177.2	142.0	34.5	40.7
1962	190.2	153.6	35.9	41.7
1963	194.2	157.3	37.3	42.2
1964	198.5	161.1	36.5	43.0
1965	211.6	170.3	40.3	42.4

1/ Source: Employment and Earnings, U. S. Department of Labor, Bureau of Labor Statistics

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

With the advent of hydraulic monsters of 50,000 ton capacity, whole auto sections can be shaped by one machine. Wrappers, stretchers, steam and pneumatic hammers today are capable of forming metal as if it were a child's clay. Some sophisticated machinery has future applications yet to be tried in mass production. Other machinery is simply building heavier compressions capable of stamping thicker and broader sheets of metal. A few of the 25 stamping and metal forming techniques are briefly outlined here.

Metal forming techniques have made very significant advances as demands for seamless products, uniform quality of surfaces and the introduction of rare metals was necessary for progress in the aerospace industry. Applications to other industries have diffused the benefit.

Many stamping machines still in use require the placing of precut metal strips, or blanks, into the machine by hand. Except in fine die stamping, and where heavy stampings are involved, this is an obsolete process. For the past 15 years, metal machines with hand feed have been replaced by continuous feed machines. Rolled flat stock of steel, copper, brass, or other metal, is drawn into automatic machines that cut the blank, feed the waste to a bin, cup the blank, and passing through several steps within one machine, pierce, trim and form finish shapes. A single machine can readily form a metal shape the size of a drinking glass at the rate of 50 per minute when using 20 gauge steel and a relatively simple press.

Most common among stamping machines today are pneumatic applications to position and eject parts on machines. Fluid pressure forming with a rubber bag is a new technique. This is a bag-type press around the metal blank and is designed for pressures of 5,000 pounds per square inch, a relatively high order for metal forming. Hydroforming, another technique, shapes metal by equalizing the pressure of the male die against the pressure of the female or press base chamber. Die-quench forming stamps preheated metals with a cold press. Uniform stretching without a spring-back action from the part produces shapes with no warpage or residual stresses that could fracture where weakened by a thin wall.

Stretch forming is used in shaping aircraft surfaces and metal tanks. Firmly held at both ends by mechanical jaws, the metal is pulled tightly over a stationary die.

There are two types of explosion forming that have been useful in making large end plates for storage tanks and pressure vessels. The first type is called "contact explosion" and places an explosive charge next to the metal for direct impact. The second, classed as "standoff operations", locates the charge a few feet from the workpiece and explosive energy is transmitted to it through a medium of air, oil, or water. A die on the opposite side of the charge catches and forms the metal on the impact. Water, being practically non-compressible, will transmit the explosion more efficiently and uniformly to the entire area of the blank.

Electrohydraulic forming uses the uniform pressure of liquid the same as the explosion technique. Instead of an explosion, the shock wave is generated by an ultra-rapid discharge of a high amplitude electric current from two electrodes immersed in water. The intensity of the shock is easily controlled by the amount of stored energy applied to the electrodes.

Forming of metal housewares requires dies, jigs and fixtures to punch, draw, spin, and form, as in the aforementioned processes. In addition, porcelain enamel is applied to some housewares by dipping raw metals into baths of porcelain and baking dry. Spot welding and even metal glue is used to fabricate some metal parts.

Raw Materials and Materials Handling

Sheets of primary metals, either in flat rectangular shapes or rolls weighing up to 4 tons are fed into the metal stamping machines with the aid of materials handling equipment. Efficient plants locate the heavy stamping operations close to the receiving or storage room to eliminate excessive handling. Plants devoted primarily to metal stamping would place the heavier operations nearer the storage area than the light operations.

Fork lift trucks equipped with booms spear the doughnut-shaped coils and carry them to the stamping area. Frequently, coils are welding to the coil in process to eliminate shutdown of the operation. Seamless welds are possible with suitable machinery. Raw stock for feeding light strip stamping machines is coiled on enclosed reels that feed down into the press like a typewriter ribbon. Blanked out scrap is collected in bins or tubs and carried away by lift trucks. About 1/3 of the original metal is scrap. During the recent copper and brass shortage many contracts required the return of this scrap to the seller for reprocessing, thus assuring a uniform price and supply to the producer.

Manpower Utilization

About three-fourths of all employees in a metal stamping operation are production workers. One out of four of the productive workers is a woman employee. Although no exact ratios can be determined, heavy stamping operations tend to employ all male production workers in line with the physical handling requirements.

Female labor is used in various departments of light metal stamping. Many light stamping operations entail a large female labor force that can work while seated in front of a machine placing the metal blanks, activating the press, and removing the finished parts. Precious metals require individual operators for each machine to avoid excessive waste should a part be off the standard tolerance. Assembly, inspection, and packing for finished end products that are comparatively light suit the women in the work force.

A typical metal stamping plant of 150 employees might have the following work force divisions:

Operation	Number of employees
Stamping, blanking & forming metals	100
Tool & die shop	20
Machine shop	10
Painting, lacquering & enameling	10
Coating & electroplating	5
Materials handling, maintenance & inspection	5

Production workers who might also be employed in a metal stamping operation include those working in nonferrous die casting, forging, pressing, hammering, electroplating, galvanizing, enameling, heat treating, foundry pattern work, and plate and structural fabrication.

Interproduct Competition

Powdered metals, plastics and metal extrusions are the potential substitutes for parts that are presently manufactured by a metal stamping process. Unique configurations and stress specifications may have a particular place for these substitutes, but long runs of common metal stampings generally result in lower unit costs. Greater automation in stamping machinery will contribute to increasing the margin of cost benefit metal stamps have over potential substitutes.

In particular, plastics, powdered and extruded metals do not have the qualities of resiliency and torsion capable in steel metal stampings. Raw material costs for sheet steel are far less expensive for most applications. Uniform surface and range of plating capacity enhance brass metal stampings where finish is important.

Distribution

Metal stampings from job shop operations are usually sprayed with oil for protection from the elements, packed in large fibre drums, in the case of small parts, and shipped by rail or truck to the customer.

As mentioned earlier, the metal may be owned by the customer. The job contract specifies the terms of scrap allowance and transportation costs. As in the case of Detroit and the auto industry, job shop operations tend to cluster around their prime customers. A private truck, owned by the customer, often delivers raw stock daily to the job shop and picks up finished stampings. These shipments in both directions balance a private truck operation and justify their capital cost to a major firm, but generally not to a small company.

Motor common carriers handle 60 percent of the metal stampings traffic, according to the 1963 Census of Transportation; rails handle 24 percent; private trucks 12 percent; with the remainder spread among water, air and other means of transportation.

Direct sales on a standard job contract basis between the metal stampings company and its customer is a normal procedure. Middlemen or jobbers are not often found, except in rare metals or special coating procedures. Sometimes a metallurgist will protect his process knowledge by dividing the work among several subcontractors. Instead of allowing the subcontractor to ship to his customer, the jobber will collect and reship the metal stampings under his own name.

Distribution of housewares such as cooking utensils, goes through the normal retail channels. Large department stores and chains buy direct, while the small store buys from a franchising wholesaler. Regional company warehouses or public warehouses are common and contribute to a relatively high cost of storing bulky pots and pans. Warehouse costs are based on cubic footage for this type of commodity. These high costs of storage and market penetration have been prime movers to initiate regional production facilities for some of the major houseware producers. Small producers without the volume, could not afford the expense of regional plant overhead.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

This section relates the importance of each plant location factor. Market orientation is the prime locational determinant for metal stampings operations.

Manufacture of metal stampings has no special requirement for power, water, plant site, or a large number of exceptional skills. Most communities within Appalachia could sufficiently supply or attract all of these locational factors today. Raw material orientation is not as important as that of market considerations. As mentioned in Section II, more than 80 percent of the metal stamping industry's demand comes from other manufacturers. It is a supporting supplier to major metal fabricators.

Market Orientation

In the past ten years there has been a diffusion of metal industries throughout Appalachia and surrounding markets. Supporting industries, such as metal stamping and electroplating, have lagged in this movement. Cost of moving inhibits the metal stamping firms from following the pattern. Also, the willingness of large customers, formerly neighbors of the metal stamping firm, to absorb shipping charges on stampings has eased the urgency of moving.

Today there is a sufficient demand to justify a branch plant for stamping operations that could penetrate industrial markets in textile machinery, aircraft parts, transportation equipment, office machinery, and appliances. These industries, located in or near Appalachia, have already established a market for metal stampings.

Relatively few metal stamping firms have recognized this market. Locational activity as measured by the 1963 Census of Manufactures for the industry between 1958 and 1963 is shown in Table 8.

Table 8.

Locational activity for the metal stampings industry 1/

(Net change)

	Establishments	
	Total U.S.	Appalachian Region
1963	2,574	118
1958	2,456	116
Net increase (decrease)	118	2
Percent change	4.8	1.7

1/ Source: 1963 Census of Manufactures

While the census counts a net gain of only 2 plants for the 1958 to 1963 period, a detailed count reveals 8 new plants and 7 expansions within Appalachia between 1962 and 1966. Nine of the 15 recent new plants or expansions were located in Pennsylvania; Tennessee and Alabama each had two; and one was in eastern Kentucky. Some of the products represented in these recent new plants and expansions include: steel sinks, irrigation pipe couplings, steel shelving, appliance replacement parts, bottle caps, and advertising decorations.

Experience in new plant locations discloses that market penetration resulting in sales increases up to 80 percent usually occurs. Close sales contact and improved service account for this marked improvement in sales. The metal stampings industry, in particular, lends itself to this market penetration factor. Competition among metal stampings firms within Appalachia is still weak. Liaison with customers who use stampings would reduce specification changes and mistakes in blueprint interpretation. More frequent sales contact alone would create additional sales.

Reduced transportation costs and shorter lead times are the major locational factors from a marketing point of view. Freight rates might drop from $3.75 per hundred weight to $.30 for an intracity movement. Next day delivery might displace fourth or fifth day.

Raw Material Orientation

Sheet and coiled steel are sold on a freight-equalized basis where consumers absorb charges from the nearest producing point, regardless of shipment origin. Copper, brass and aluminum stock is generally shipped on a delivered basis.

Producing points for cold-rolled steel are located in Pennsylvania, Alabama, and Maryland. These, in effect, place Appalachian points within range of a 24-hour delivery time. Brass sheet stock is centered in Ohio and Connecticut. Aluminum sheet is available in Tennessee and West Virginia. Supplies of raw materials for nearly all specifications are available within Appalachia.

Locational activity will tend more to market orientation than raw material orientation primarily because freight costs are far less for raw materials than finished products. Stamped objects tend to be bulky, which might carry freight ratings up to class 200, whereas a flat steel commodity rating could be as low as class 30 by motor carrier, and even less by rail.

Shorter lead time on finished metal stampings generally require immediate shipment to maintain a constant supply to the customer. On the other hand, steel shipments to the stamping company may be in carload lots only once a month. Large steel stocks, relatively inexpensive when compared to finished products, can be maintained within reasonable limits. The value of finished stampings, their tendency to be bulky, and the urgency of filling customer requirements keeps the product moving from the production line.

Labor Requirements

A new stamping plant in Appalachia could meet its labor requirements as follows: import skilled labor at a premium; train semiskilled workers by in-plant training and vocational school training, where available; train unskilled workers on the job.

As shown under "Manpower Utilization" in Section III, there are about 2 operators in stamping, blanking and other metal forming operations for each of the other production workers within a metal stamping plant. These stamping and blanking machine operators require relatively little skill, but a high degree of coordination. Some automatic stamping machines might require only a monitor to stop the press when a standard is not met or the machine runs out of raw material. One setup man, a highly skilled machinist, could handle the adjustments to a dozen machines.

Materials handling can account for up to 80 percent of the direct labor cost in a metal stamping operation. This is particularly true with highly automated presses where feeds and machine extractions are handled by near-human action of suction, clamps, and levers.

Operators for automated stamping or foot-actuated "kick presses" require low grades of relatively unskilled labor. A few days of in-plant training can acclimate a worker who has been accustomed to the noise of a factory. Raw labor from rural areas, unaccustomed to factory operations, would best be placed in jobs requiring material handling away from machinery for a few months, until acclimated to the plant.

Highly skilled tool and die men, and machinists are difficult to locate in any area today. Appalachia would be no exception. These skilled positions would, of necessity, be filled by importing labor from other areas at a premium.

Semiskilled operations in enameling, porcelain, or other metal coating operations allied to the finish of metal stampings, would have to be trained by a cadre of key personnel. If the new plant is a branch operation of a main plant, a staff of 15 to 20 men from the main plant could set up an in-plant training program for the semiskilled requirements.

Other Location Factors

Power of 350 kw would readily supply the needs of a 300-man metal stamping plant. Power is not a major locational factor.

State and local tax climate are lesser considerations when locating a metal stamping plant. However, heavy machinery operations would tend to locate in communities where local assessments are restricted to real estate.

Site requirements for the metal stamping industry are minimum for any manufacturing operation. Fifteen acres of usable, drained land is of sufficient size to accommodate a 250-man plant. Sites serviced with paved roads, water, sewer, and electric power would be considered sufficient. Communities that have built shell buildings to accommodate industry would find a suitable market among versatile metal stamping plant layouts. Rail sidings are not necessary, but helpful in negotiating volume rates on raw material.

Community amenities that attract blue chip industries are not necessarily the most important location determinants for a metal stampings operation. High standards for education, adequate police and fire protection, a stable assessment and tax policy, and a local government attuned to industrial development potential are contributing location factors that would gain the attention of management in a metal stampings company.

4

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

This section of the report establishes the priority of action necessary to make Appalachia more attractive to firms in the metal stampings industry.

Construction of east-west corridor highways are of prime importance to the industrial market-oriented metal stampings industry looking at Appalachia for an industrial plant site. Other location factors that will enhance selection of Appalachian sites were outlined in Section IV. Programs and policies that contribute to their improvement are mentioned in this section.

Many location factors already present in Appalachia meet the essential needs for a metal stamping firm. Improving the access to markets is most important, and the improvement of the other factors will lend incremental strength to a location determinant.

Access to Industrial Markets

Transporting the finished metal stampings to industrial customers must flow as regularly as if the supply were within the customer's plant itself. A customer's production line of 300 workers could be shut down if metal stamping parts for assembly are not delivered on time.

Highway transportation, either by company truck or common carrier, transport nearly 80 percent of the products from the metal stampings industry. Federal, state, and local funds that cut east-west corridor highways, and feeder roads to these corridors, will substantially support an uninterrupted supply system.

Corridors that lead to existing markets for metal stampings would include the following: to service the textile machinery industry, a highway from the area of Pikeville, Kentucky to Asheville, North Carolina, and connecting with U.S. Highway 26 is suggested; to open the automotive parts market, a major highway leading from the area of Pikeville, Kentucky north to Columbus, Ohio; and from the area of Altoona and Hollidaysburg, Pennsylvania a corridor highway might be built south to the Pennsylvania Turnpike; to facilitate transportation from central Appalachia to the appliance market, a corridor highway from the area of Pikeville, Kentucky to Winchester, Kentucky is suggested; and to enhance the supply of metal stampings to the burgeoning office machinery and furniture manufacturing centers, a corridor from Lock Haven, Pennsylvania to Elmira, New York is suggested.

While each of these corridors enhances the market situation for the relatively minor metal stampings industry, substantial interindustry supply support would benefit by similar highway patterns. The manufacture of pumps, valves, textile machinery, automotive parts, office machinery, materials handling equipment and instruments, all integral to the industrial development of Appalachia, would receive similar benefit of improved parts supply.

Rail transportation service from Pittsburgh south to southeastern Kentucky points and from Bessemer, Alabama north to the same area of Kentucky is extremely circuitous because of topography. In addition to natural barriers, as many as 4 carriers converge onto the same general abandoned coal mine area. If Interstate Commerce Commission policies encourage merges of rail lines, they should attempt to provide single-carrier service between the northern areas of Appalachia and those in the south. Joining services in eastern Kentucky would alleviate rail interchange delays. Supply of steel and other raw materials not suited for slow water transportation would be enhanced by direct single-line rail service.

Improved air transportation would not affect this industry's location decision to any great degree because the industry's raw materials, products, and personnel are not heavy air transportation customers. Once a sale is made in this industry, there is not the same customer liaison necessary as in the instruments or office machinery industries, for example.

Short lead times, potential corrosive effects near water, and limited access to markets make water transportation of metal stampings prohibitive.

Labor Supply

Skill requirements for the metal stamping industry are limited. Section III under "Manpower Utilization" and Section V under "Labor Requirements" identified the manpower needs of the metal stamping industry. A metal stamping plant could locate in many Appalachian communities today without additional trained labor. There is, however, a long-range need for tool and die makers, tool machine operators, enameling and electroplating specialists. These occupations should be trained in regional vocational schools to provide rural areas with skills suitable for this industry. Metal stamping firms would tend to locate in rural areas more than many of the other industries included in this series of reports to the Appalachia Regional Commission.

These skill requirements also fit the needs of other industries suggested by this report as integral to the industrial development of Appalachia.

Emphasis of these particular skill requirements in rural regional vocational schools is important. First of all, metal stamping operations might fit into relatively light serviced rural communities where other industries might require the full services of urban centers. Secondly, the mechanical aptitudes of farm labor, accustomed to work around tractors, old cars, and farm machinery, would readily adapt to machinery operations. The more astute could conceivably work into tool and die trades if cultivated by apprenticeship in local industry.

Other Areas of Public Investments

Communities which can satisfy the primary locational requirements can bolster their competitive position for the metal stampings industry by providing a suitable shell building. While this might be either a newly constructed or recently renovated structure, to be effective it must satisfy basic requirements of access, parking, utilities, and, of course, freedom from flooding. Open, single story structures will be preferred.

Further enhancing an area's competitive position will be the availability of financial assistance. Either revenue bond programs or local subscription will usually provide sufficient incentive. Where necessary, the community should be responsive in extending both utilities and services.

The attractiveness and livability of a community, while not considered a primary locational determinant, will frequently be the deciding factor between 2 or 3 communities which are otherwise equal. Thus, in striving to attract new industry, this factor must not be overlooked.

Education

Basic education standards in many areas of Appalachia should be improved. A minimum of eighth grade reading and comprehensive, the writing of basic English, and simple mathematics below algebra should be standard levels of achievement.

Funds allocated to recycling slow, but competent, students should center on new concepts. Automated teaching machines; mathematics taught by tangible blocks called "queissennaire rods"; and teaching by concrete examples before the abstract theory are some fundamental methods proven in advanced systems throughout the country and in the armed forces.

Funds directed to upgrading basic education will encourage long-run industrial development. Higher education standards create a large selection of candidates for the more highly skilled phases of the metal industry. Job opportunities such as tool and die makers, machinists, and the numerical control of stamping machines are going to need qualified trainees. Industry will prefer to locate in regions where they find these skills.

Financing

Private investment incentives, that in turn provide job opportunities, should be encouraged even further than existing laws allow. For example, Title IV of the Economic Opportunity Act of 1964 provides small firms with additional loans and loan guarantees which today are limited to $25,000, an amount entirely ineffective for this industry.

Raising the limits of guarantees to $150,000, with perhaps less liberal terms of contract, would encourage the responsible entrepreneur to invest in metal stampings or other low-capital industry. Small businesses in metal stampings, attempting to market new and well-founded products, would thereby get a start.

Other Public Investments

Funds allocated to waterway transportation, public power, timber development, land stabilization, sewage treatment works, and recreation would have only a limited effect on locational activity as far as the metal stamping industry is concerned.

Appendix A

SELECTED INFORMATION SOURCES

Published Information

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(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Manufacturers of metal stampings inside and outside Appalachia.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 15--THE AIRCRAFT AND AEROSPACE PARTS INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such industry, specifically Standard Industrial Classification industry code 3729, Aircraft Equipment, not elsewhere classified.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

The aircraft and aerospace parts industry employs 170,000 people. In 1964 its share of value added in the national economy amounted to $3.2 billion, and it contributed capital expenditures of $59 million.

SIC 37291, aircraft parts and auxiliary equipment, provided the largest component of shipments in 1964, accounting for $2.4 billion of the $3.2 billion total for aircraft and aerospace parts.

Initial inroads by major companies have been made into both northern and southern areas of the Appalachian Region, and it appears likely that more facilities will follow.

A most direct influence designed to stimulate the 12-state economy can be exerted on this industry by federal policies. The location of Appalachia between 2 large industrial areas presents an unusual opportunity for the area to benefit by federal defense contract awards, and, as a result, develop its own privately supported economy.

The 1 disadvantage to the industry is the fluctuating employment picture. However, long-term stability of the industry seems assured as transportation horizons broaden to regions in space. Offsetting this would be the industry's ability to condition the region to sophisticated metal manufacture and build a skilled labor force able to compete in the private economy.

I. PROFILE OF THE INDUSTRY

Size

The size of the aircraft and aerospace parts industry measured by national employment, value added, and capital expenditures does not fully reflect its industrial and strategic importance. Not only is it a vital cog in the aircraft industry, but it supplies parts to the guided missile portion of the ordnance industry. Close interrelationship thus develops between the entire aircraft and guided missile ordnance industry. Shown below are the relative values in employment, value added, and capital investment for the durable goods industries and aircraft and aerospace parts.

Table 1.

Rankings of the durable goods industries, 1964 1/

(Numbers in millions)

Industry rank	Employment		Value added by manufacture		Capital expenditures	
1	TRANSPORTATION EQUIPMENT	1.62	TRANSPORTATION EQUIPMENT	$23,961	Primary metals	$1,887
2	Machinery	1.54	Machinery	19,762	TRANSPORTATION EQUIPMENT	1,297
3	Electrical machinery	1.48	Electrical machinery	18,039	Machinery	946
4	Primary metals	1.18	Primary metals	16,732	Electrical machinery	889
5	Fabricated metals	1.12	Fabricated metals	12,636	Fabricated metals	728
6	Stone/clay/glass	.58	Stone/clay/glass	7,520	Stone/clay/glass	626
7	Lumber/wood	.56	Lumber/wood	4,361	Lumber/wood	369
8	Furniture	.39	Instruments	4,333	Instruments	165
9	Instruments	.31	Furniture	3,225	Ordnance	117
10	Ordnance	.23	Ordnance	2,871	Furniture	106
	AIRCRAFT & AEROSPACE PARTS	.17	AIRCRAFT & AEROSPACE PARTS	1,966	AIRCRAFT & AEROSPACE PARTS	59

1/ Source: 1964 Annual Survey of Manufactures, U. S. Department of Commerce.

Production of aircraft and aerospace parts accounted for about 26 percent of the total employment in the aircraft and parts industry (SIC 372), and 25 percent of the value added by manufacture. New capital investment, reported at $59,651,000 in the 1964 Annual Survey of Manufactures, claimed 22 percent of industry SIC 372's investment.

Products and Markets

Table 2 relates the significance of 5 subclasses of the industry based upon the dollar value of shipments.

Table 2.

Industry shipments by production segment 1/

(Percentages based on dollar value)

SIC	Classification	Shipments % of total
37291	Aircraft parts and auxiliary equipment	64.3
37292	Guided missile components and subassemblies, N.E.C.	21.2
37294	Receipts for research and development on missile components, N.E.C. 2/	11.1
37293	Receipts for research and development on aircraft parts	2.1
37290	Aircraft equipment, N.E.C., N.S.K. 2/	1.3
	TOTAL AIRCRAFT EQUIPMENT, N.E.C.	100.0%

1/ Source. 1964 Annual Survey of Manufactures.

2/ Note: N.E.C. (Not elsewhere classified)
N.S.K. (Not specified by kind).

The product lines pertinent to the plant location aspects of this report make up approximately 87 percent of the aircraft equipment industry (SIC 3729). Not generally appreciated, the other aircraft and parts and auxiliary equipment industry turns out a product value roughly equivalent to that shipped by electronic components (SIC 3674,9). Table 3 lists the value of shipments by product lines discussed in this report.

Table 3.

Value of selected product shipments 1/

SIC	Product class	Value of shipments ($ million)
37291	Other aircraft parts and auxiliary equipment .	$2,364.9
37292	Guided missile components and subassemblies, N.E.C.	779.8
37290	Aircraft equipment, N.E.C., N.S.K.	48.2
	TOTAL	$3,192.9

1/ Source: 1964 Annual Survey of Manufactures.

Note: Represents shipments only from those establishments whose major production is within the specified industry.

Markets served include airframe assembly companies, aircraft manufacturers, space exploration and missile defense prime contractors, also the Federal Government. Located within the Appalachian Region are 2 major contract letting facilities, the Redstone Arsenal and the Marshall Space Flight Center, both in Huntsville, Alabama. Heavy procurement of missile and space parts by these agencies have helped stimulate Huntsville's 160 percent industrial job gain between 1961 and 1965.

Within easy reach of the southern portion of the Appalachian Region is the aircraft plant in Albany, Georgia which scheduled a production of 300 light airplanes in 1966, and 840 for 1967. Further north, within Appalachia itself, aircraft plants at Lock Haven, Aliquippa, and Morton, Pennsylvania, along with operations nearby, but outside of Appalachia, in Philadelphia, Pennsylvania, provide additional markets. In Maryland, an Appalachian plant at Hagerstown and extensive facilities in Baltimore require parts and subassemblies. Customer plants in Columbus and Middletown, Ohio, in addition to Buffalo, Elmira, and Bethpage, New York round out northern Appalachian markets.

Back in the South, a major plant in Marietta, Georgia and a maker of large subassemblies in Nashville contribute further to the market available to Appalachian producers. A new plant, now under construction, in Charleston, South Carolina extends this market further.

Plant Ownership and Size Structure

Of the 1,000 plants classified as aircraft equipment, N.E.C. (SIC 3729), the 1963 Census of Manufactures lists 302, or 25 percent, employing more than 50 workers. Plants staffing more than 1,000 number 35, while those employing between 50 and 100 total 103. One of the newest plants, which is locating in Tennessee, will operate a 40,000-square-foot facility and hire about 100 workers. In contrast, a parts plant located close by in Nashville has 3,200 persons on the payroll. From a plant location standpoint, 2 operational methods find current favor: the wholly integrated large parts plant and the cluster of smaller plants shipping components to a central location for assembly into larger parts.

Geographic Prevalence

According to the 1963 Census of Manufactures, aircraft and aerospace parts plants are found in 39 states. States with 10 or more plants number 18. Regional dispersion is shown in Table 4 below.

Table 4.

Regional distribution of establishments 1/

Geographic area	SIC 3729 Aircraft equipment, N.E.C.
New England	
Total plants	63
Employing over 50	18
Middle Atlantic	
Total	149
Employing over 50	59
South Atlantic	
Total	48
Employing over 50	19
East North Central	
Total	152
Employing over 50	49
East South Central	
Total	8
Employing over 50	7
West North Central	
Total	61
Employing over 50	15
West South Central	
Total	47
Employing over 50	15
Mountain	
Total	27
Employing over 50	12
Pacific	
Total	445
Employing over 50	108
UNITED STATES	
TOTAL PLANTS	1,000
EMPLOYING OVER 50	302

1/ Source: 1963 Census of Manufactures.

Appalachian Specialization

Approximately 7.8 percent of the plants employing 50 or more are located in the Appalachian Region (Table 5). In addition to those shown in the Bureau of Census tabulation, new plants under construction in Putnam, Smith, Jackson, DeKalb, and White counties, Tennessee in 1965 and 1966 up the data for the Appalachian Region. Extended operations by several firms in Huntsville, Alabama also add to the list.

Table 5.

Establishments within the Appalachian Region employing 50 or more SIC 3729 - aircraft equipment, N.E.C. 1/

	Number of establishments with employment of				
	50-99	100-249	250-499	500-999	1,000 or more
New York					
Broome					1
Total	-	-	-	-	1
Pennsylvania					
Luzerne		2			
Monroe	1				
Total	1	2	-	-	-
Maryland					
Washington					1
Total	-	-	-	-	1
North Carolina					
Buncombe		1			
Total	-	1	-	-	-
Georgia					
Barrow		1			
Total	-	1	-	-	-
Tennessee					
Coffee			1		
Hamilton		1			
Total	-	1	1	-	-
Alabama					
Etowah	1				
Total	1	-	-	-	-
APPALACHIAN TOTAL	2	5	1	-	2
UNITED STATES TOTAL	103	88	47	29	35

1/ Source: 1963 Census of Manufactures.

Economic Impact

To segregate the economic impact of the aircraft and aerospace parts industry (SIC 3729) from the 3-digit classification, aircraft and parts (SIC 372), becomes virtually an impossible task. As shown in Table 6 below, the combined industry is its own best customer. In terms of 1958 dollars, it purchased $190.20 from itself for each $1,000 of gross output. These large intraindustry purchases lead to a redundancy of transactions not reported in the National Income and Product Accounts.

Table 6.

Direct requirements per $1,000 gross output 1/

(Based upon producer's prices, 1958 dollars)

Purchases from other establishments	Aircraft and parts
Aircraft and parts	$ 190.20
Ordnance and accessories	51.74
Primary iron and steel manufacture	31.93
Radio, television, and communication equipment	27.09
Metalworking machinery and equipment	19.42
Stampings, screw machine products, and bolts	19.34
Wholesale and retail trade	18.04
Primary aluminum manufacture	15.99
Scientific and controlling instruments	15.52
Other primary nonferrous manufacturing	11.50
General industrial machinery and equipment	10.85
Other fabricated metal products	10.32
Subtotal	$ 421.94
Other industries	105.85
Total purchases	$ 527.79
Value added	472.21
TOTAL	$1,000.00

1/ Source: Scientific American, October, 1966.

Based on an estimated Gross National Product of $750 billion for 1967, the aircraft and parts industry (SIC 372) should account for $19.4 billion of the resulting Gross Domestic Output of $1,296 billion. Total delivery to final demand is expected to reach $10.9 billion. The Federal Government constitutes the major ultimate market, taking $9.2 billion of the final demand.

Value added, made up of the prime factors of production (capital charges, labor, and profit) claims $472.21 of each $1,000 of output. Value added for 1967 is predicted at $9.1 billion and represents the industry's contribution to Gross National Product.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production

Aircraft and aerospace manufacture, a principal market for parts, will get a strong boost from defense spending. In addition, major subcontract work on the SST (1,800-miles-per-hour airplane) prototype is being let by the 2 aircraft companies competing for the supersonic transport award. Heavy demand for helicopters for Vietnam, along with the requirements for space exploration rockets, jet passenger aircraft, and cargo jets give sharp impetus to increasing production.

Sales

The step-up in defense spending will contribute strongly to an expected 7 percent growth in physical volume. Airlines that converted to jets in the 1959-1961 period have again entered the marketplace and are signing new orders for jets and prop jets.

Six leading aircraft and aerospace parts companies now share in the $150 million subcontract work for the SST. Based upon the Federal Aviation Agency's proposal for an initial production of 200 SST's, more than $1.5 billion in subcontracts should result. Furthermore, work will continue on the giant C-5A jet transport now being built in Marietta, Georgia. The C-5A, designed as the world's largest airplane, measures 245 feet long, has a wing span of 222 feet, a tail height of 65 feet, and weighs more than 700,000 pounds. The Air Force has ordered 58 and holds an option for 57 more.

Increased sales of the DC-9 short- to medium-range twin jets and the A-4E and A-4F combat jet call for more sales by parts manufacturers. One company has 5 new parts plants going on stream to meet this latter demand.

The following will give an idea of the comparative material requirements for an SST and a standard 707 jet transport.

	707	SST
Length	152 feet 11 inches	306 feet
Wing span	142 feet 5 inches	174 feet at maximum sweep
Height	42 feet	48 feet
Gross weight	316,000 pounds	675,000 pounds

Sales of aircraft parts and equipment, N.E.C. (SIC 3729) to the Federal Government totaled $2.7 billion in 1963. Of this total, other aircraft parts and equipment (SIC 37291) took $1.5 billion, and guided missile components and subassemblies (SIC 37292) captured $755 million. The DOD (Department of Defense) let the lion's share of the contracts, $1.4 billion going to SIC 37291, and $625 million to SIC 37292.

Shortages of combat planes due to war losses have been larger than the production rate for comparable replacement aircraft. Inventory stocks have shrunk drastically. The DOD has recently authorized 280 additional combat planes, but even this additional production will not balance the loss rate of 4 percent per 1,000 sorties until 1968.

The demand for cargo plane parts will follow the increased use of air cargo freight shipments. The aviation industry expects to surpass 1970 volume forecasts by the end of 1966. While passenger traffic was up 17 percent this past year, cargo traffic jumped 33 percent.

The cargo activity at 1 airport, Newark, which is the second largest air cargo terminal in the world, illustrates the trend. Cargo traffic here has almost doubled in 5 years, climbing from 58,000 tons in 1960 to 99,000 tons in 1965.

The demonstrated capacity of jets carrying cargo to yield higher trip profits per aircraft than passenger transports has stimulated orders for 101 jet freighters to be delivered by 1968. The jet freighter fleet will triple in the next 2 years and airline investment will amount to $1.2 billion, an amount equal to all flight equipment as recently as 1955.

The light plane market, after a staggering start immediately following World War II, has finally taken off the ground. Light plane manufacturers are feasting on record sales. Back in 1947 sales totaled 15,000 aircraft. However, the following year the output amounted to about 7,500, and by 1949 plants turned out less than 3,700.

The outlook brightened in 1965 when sales again climbed to 10,000, and manufacturers saw the dawn of new expectations as they fabricated 12,000 units during the year--a 27 percent jump over 1964. Production in 1966 is headed toward a 16,000 record. With 20,000 new Americans earning pilots' licenses each year, private plane sales and the requirement for parts and subassemblies should continue the current trend which started in 1962.

One manufacturer calculated that 14 of every 100 beginning flight students will eventually buy a plane; 10 of these will be used aircraft and 4 new. The industry's goal is to get 200,000 new student pilots in 1968. The Federal Aviation Agency issued roughly 93,000 student pilot licenses in 1965.

The relationship between sales of aircraft (SIC 3721) and aircraft parts (SIC's 37290 and 37291) is pointed up by the change in output from 1958 to 1963. The dollar value of work done declined 19 percent for aircraft while that for aircraft parts dropped 20 percent in almost parallel movement. A similar shift, but in the opposite direction, took place in guided missiles, complete (SIC 19251) and guided missile components and subassemblies (SIC 37292) as both sectors showed respective rises of 83 percent and 98 percent.

Profits

Aircraft parts and accessories (SIC 372) firms' net profits on sales fell below comparable all manufacturing returns of 6.1 percent in 1964. (See Table 7.) However, the return on tangible net worth exceeded the all manufacturing average. The same relationships held for 1965. Furthermore, the profit ratio on tangible net worth grew at more than twice the rate of all manufacturing from 1964 to 1965. Net income after taxes for 1965 jumped 29 percent.

One leading company, which manufactures fuselage sections, horizontal stabilizers, and pod assemblies, has seen its profits of $2.03 million on sales of $104.16 million rise to $4.84 million on sales of $158.72 million from 1963 to 1965. In contrast, another major firm focusing primarily on military and other government procured aircraft and aerospace assemblies recorded corresponding profit/sales relationships of $7.09 million/$329.00 million and $5.98 million/$336.21 million for 1963 and 1964.

Table 7.

Profit ratios in the
aircraft and aerospace parts industry 1964 1/

	SIC 372 Airplane parts & accessories (56)	All manufacturing (2,298)
Net profits, percent		
On sales	5.46	-
	3.33	6.1
	1.04	-
On tangible net worth	16.23	-
	9.60	12.6
	3.02	-
On net working capital	28.70	-
	17.09	-
	6.02	-

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc. and First National City Bank's Monthly Letter of April 1966.

Employment

Although industry employment data from the Bureau of Census and the Department of Labor disagree in both absolute terms and magnitude of change, both show an identical trend from 1958 to 1963--downward. Bureau of Census employment figures closely match the percentage decline in output, 18 percent, while Department of Labor figures which combine SIC's 3729 and 3723 indicate a much steeper drop. (See Table 8.)

Table 8.

Employment change of the aircraft parts industry, 1958-1965 1/

	All employees (000)	Census all employees (000) 2/	Production workers (000)	Census production workers (000) 2/
1958	147.7	213.5	102.4	144.1
1959	138.5	-	93.4	-
1960	116.9	-	74.6	-
1961	106.0	-	67.9	-
1962	104.9	-	65.6	-
1963	102.6	175.2	66.7	111.4
1964	96.2	-	63.2	-
1965 (August)	100.2	-	67.5	-
Percent change 1958-1963	30%	18%	35%	23%

1/ Source: Employment and Earnings Statistics for the United States 1909-65 (SIC 3723 and SIC 3729) U.S. Department of Labor, Bureau of Labor Statistics.

2/ Source: 1963 Census of Manufactures, Bureau of Census, Department of Commerce (SIC 3729).

However, it should be noted that the Bureau of Labor Statistics figures for 1966 may indicate a trend reversal. The Aerospace Industries Association predicts an 11 percent employment increase over December 1965 by the end of the year. Missile employment has stabilized as some systems phase out and others increase. Demands for increased cargo and passenger planes, along with greater military demands, will account for most of the growth.

Investment and Location Activity

Despite the industry's optimistic outlook, 1 year ago it was operating at only 79 percent of capacity, 10 points below its preferred rate. Nevertheless, aircraft and aerospace companies, projecting long-term growth trends, are girding themselves for what is expected to be a vastly larger market of the 1970-1990 period.

Aerospace and aircraft companies, unless severely restricted by government investment containment policies, plan the largest increase in capital investment of any major industry. Investments in 1966 for new facilities should total over one-half billion dollars, but preliminary plans for 1967 indicate investments next year at 11 percent below the 1966 level

Mirroring the 5-year employment trend, the number of plants as measured by the 1963 Census of Manufactures declined 16.7 percent nationwide. At the same time, new plants moving into Appalachia brought about a net increase of 13.4 percent. The last 2 years have seen 5 new plants in Tennessee.

Table 9.

Comparison of the number of Appalachian plants (SIC 3729) for the years 1958 and 1963 1/

(Net change)

State & county	Establishments	
	1958	1963
New York		
Broome	1	1
Chemung	1	–
Total	2	1
Pennsylvania		
Fayette	1	–
Erie	–	1
Luzerne	4	3
Monroe	–	1
Northumberland	–	1
Washington	–	1
Allegheny	1	–
Crawford	1	–
Westmoreland	1	–
Total	8	7
Maryland		
Washington	1	1
Total	1	1
West Virginia		
Ohio	–	1
Berkeley	1	–
Total	1	1
North Carolina		
Buncombe	–	1
Total	–	1
Georgia		
Barrow	1	1
Rabun	–	1
Total	1	2
Tennessee		
Coffee	–	1
Hamilton	–	1
Knox	1	–
Total	1	2
Alabama		
Etowah	–	1
Madison	–	1
Total	–	2
Kentucky		
Carter	1	–
Total	1	–
APPALACHIAN TOTAL	15	17
UNITED STATES TOTAL	1200	1000

1/ Source: 1963 Census of Manufactures.

III. TECHNOLOGY AND TRENDS

Technological Backup

Two major areas of technological backup for aircraft and aerospace parts manufacturers operate within 60 miles from each other in Huntsville, Alabama and Tullahoma, Tennessee. United States Army employment of 13,000 at the Redstone Arsenal and the 7,500 workers at the Marshall Space Flight Center anchor the Huntsville aerospace complex for 42 large industrial employers, each hiring 250 or more operatives. The 2 largest employ over 5,000. Altogether 17 of these firms provide missile and aerospace support services including R&D work. Eight others turn out fabricated aerospace assemblies and parts.

Facilities at Tullahoma focus on the $370,000,000 investment in the Arnold Engineering Development Center. In this vast complex of wind tunnels and rocket test facilities, the University of Tennessee Space Institute operates the largest and most advanced transonic and supersonic wind tunnels in the non-communist world. The University of Tennessee provides educational programs leading to the Master of Science and Doctor of Philosophy degrees in aerospace technology.

At Huntsville, close to 4,200 are enrolled in 3 4-year colleges. The University of Alabama at its Huntsville Campus provides a graduate curriculum meeting all requirements for a Ph.D, except for a 2-semester residency requirement at Tuscaloosa.

Manufacturing Processes

Although many of the parts and subassembly manufacturing techniques in use today would call forth recognition from workers away from the industry since the early 1950's, other techniques husbanded to join and form the more exotic materials needed to meet today's in-flight environment summon startling changes in manufacturing operations.

The rapid advance in computer technology presents manufacturing applications that offer revolutionary breakthroughs in tool design, using numerical control programming techniques. Computer-aided design applications and computer graphics find increasing use in manufacturing and systems.

The fabrication of beryllium from standard sheets, bars, extrusions, or forgings into aerospace and aircraft parts is in a state of flux due to new, rapidly developing methods of utilization. Manufacturing procedures for the assembly of beryllium wing and rudder structures are being adjusted to new concepts coming from companies in St. Louis, Missouri; Burbank, California; Seattle, Washington; and Hagerstown, Maryland.

The development of titanium fabricating techniques using high temperatures in die forming and plasma arc welding uncovered during the XB-70 bomber experimental program predict greater use of this metal and further adoption in parts assembly. The effects of subsonic, supersonic, hypersonic, and orbital environments on aircraft structures have led to other modifications in the use and choice of structural materials. Many of these procedures, stimulated by Air Force opinions, remain restricted to those with classified clearance.

Manpower Utilization

The manpower drop in the aircraft and aerospace parts industry which continued from 1958 to 1965 has undergone a reversal. Since 1960 average weekly hours grew from 41.4 to 42.8. (See Table 10.) During this period the heaviest expansion emphasized missile and space related industries, where the demand for production workers is less than in aircraft parts.

For example, from 1947 to 1961 the proportion of engineers, scientists, and technicians in establishments engaged in missile related aerospace activities increased from 13 percent to 22 percent. Hourly employees, mostly representing blue collar workers, numbered roughly 54 percent in 1961 compared to 77 percent in 1947. As missile activity stabilizes and greater emphasis is directed toward hardware output, production workers will be called for in increasing numbers. However, the sophistication required for the production of parts for today's aircraft will preclude a return to the production worker ratios in vogue during the early 1950's.

Like many other metalworking industries, aircraft and aerospace parts are plagued with shortages of skilled machinists, welders experienced in exotic metal joining, tool and die makers, and technicians. Through rigorous systems design and in-plant training programs, some firms have reduced their dependence on technicians for nondestructive control testing.

Table 10.

Employment in the SIC 3723 and SIC 3729 industry 1/

Year	All employees (000)	Women employees (000)	Production workers (000)	Average weekly hours
1958	147.7	-	102.4	41.2
1959	138.5	19.6	93.4	41.7
1960	116.9	16.6	74.6	41.4
1961	106.0	14.8	67.9	42.0
1962	104.9	14.3	65.6	42.4
1963	102.6	13.7	66.7	42.4
1964	96.2	12.7	63.2	42.4
1965	100.2	13.6	67.5	42.8

1/ Source: Employment and Earnings - Establishment Data, Bureau of Labor Statistics.

Distribution

Based on a probability sample of 31,051 shipments reported by 270 establishments, the 1963 Census of Transportation indicates that trucks carry by far the weight of aircraft parts shipments. The importance of air transportation becomes significant principally for items weighing under 100 pounds. (See Table 11.) The data also shows that only 37.6 percent of the shipments travel less than 500 miles, indicating transportation considerations allow a rather wide latitude in locating a parts plant.

Table 11.

Distance and means of distribution for aircraft parts and equipment, N.E.C., SIC 3729 1/

Commodity	Tons of shipments (000)	Percent distributed by				
		Rail	Motor carrier	Private truck	Air	Other
Aircraft parts, etc.	92	10.9	73.2	3.5	7.6	4.8

Commodity	Ton-miles of shipments (000)	Percent distributed by				
		Rail	Motor carrier	Private truck	Air	Other
Aircraft parts, etc.	79	8.1	76.0	0.4	8.5	7.0

Commodity	Tons of shipments (000)	Percent distribution of shipments by mileage classes						
		Under 100	100-199	200-299	300-399	400-499	500-999	Over 1,000
Aircraft parts, etc.	92	10.9	8.0	6.4	9.0	3.3	37.0	25.4
Accumulated percentage			18.9	25.3	34.3	37.6	74.6	100.0

1/ Source: 1963 Census of Manufactures.

Because of sizable tooling requirements, changing specifications, and customary aircraft and missile subcontracting procedures, parts and subassemblies manufacturers generally produce on signed orders only. More than 1 producer will often share a contract for a specific part as demonstrated by the 6 leading aerospace companies chosen for major subcontract work on the SST. By the same token, 1 parts firm may hold subcontracts for unrelated sections of different aircraft produced by individual aircraft makers.

IV. PRIMARY FACTORS INFLUENCING THE SELECTION OF LOCATION

Introduction

Data from the 1963 Census of Manufactures provides a significant backdrop to the location problem of the aircraft and aerospace parts industry, and spotlights 1 reason for the 2 avenues of approach most generally utilized by parts manufacturers. Commonly, these are known as the cluster concept or the integrated operation concept.

The Census Bureau publication lists 1,000 establishments in SIC 3729 for 1963 and an employment of 175,167. Table 12 arranges these plants in a configuration which compares industry employment with number of establishments by size.

Table 12.

Employment distribution among establishments by size - industry SIC 2729, aircraft equipment, N.E.C. 1/

		Employment size						
	Total	2,500 and over	1,000 to 2,499	500 to 999	250 to 499	100 to 249	50 to 99	Below 50
Establishments	1,000	10	25	29	47	88	103	698
Percent of total	100.0	1.0	2.5	2.9	4.7	8.8	10.3	69.8
Accumulated establishments	-	10	35	64	111	199	302	1,000
Accumulated percentage	-	1.0	3.5	6.4	11.1	19.9	30.2	100.0
All employees	175,167	69,889	39,179	19,616	16,545	14,010	6,979	8,949
Percent of total	-	39.90	22.37	11.20	9.44	8.00	3.98	5.11
Accumulated employees	-	69,889	109,068	128,229	144,774	158,784	165,763	175,167
Accumulated percentage	-	39.90	62.27	73.20	82.65	90.65	94.63	100.00

1/ Source: 1963 Census of Manufactures.

Plants employing 2,500 and over constitute 1 percent of the establishments, but hire almost 40 percent of the workers. When the factories employing between 1,000 to 2,499 workers are added, the number of establishments advances to only 3.5 percent of the total and employment covers nearly two-thirds of all the people in the industry. From 500 up, the respective figures are 6.4 percent and 73.20 percent.

Operations hiring between 100 and 499 number 310, account for 13.5 percent of the plants, and give work to 17.44 percent of the industry. The largest plant group, found in the under-50 category, hires approximately 5.11 percent of the work force.

Community Size

Generally, plants in the 3 size ranges, 500 and up, 100 to 499, and below 100, present 3 differing location specifications for selecting communities in which to operate. Metropolitan areas of 35,000 or more most often fit the needs of the largest size plants. Typical locales would be Riverside, California; Hagerstown, Maryland; Nashville, Tennessee; Huntsville, Alabama; or Orlando, Florida.

Smaller plants often prefer communities below 35,000 and as small as Smithville or Gainesboro, Tennessee (labor drawing area population 11,000). Operational procedures weigh heavily in this type of location. Standard parts, undergoing only minor periodic changes, fit best. Also gravitating towards smaller communities would be a group of individual plants making components for further subassembly at a consolidating location (the cluster concept). Nevertheless, it is not unusual for a smaller company employing 150 to 200 to select a larger community such as Asheville, North Carolina (population 60,000). The reasoning in this case is that if the company is successful in capturing a contract, the work force may have to be expanded fourfold. Smaller communities present labor supply problems when a quick expansion is needed, especially in skilled categories.

Because contracts and subcontracts provide so much of the life blood of the industry, sharp employment fluctuations frequently occur, and lead to locations where the manufacturer can operate under the umbrella of a larger area employer. Thus the onus of surprise downturns in the employment picture does not fall so heavily on the plant suffering a production cutback.

The smaller plants which employ under 100 do not place such a great demand on an area's labor potential and enjoy great flexibility in this regard. Although such establishment will often cause only a lesser impact on local economic conditions, they present more location opportunities because of sheer number.

One other important factor colors the location activity of aircraft and aerospace parts producers. The large boosts in demand which outstrip capacity often come from emergency military needs. Suddenly thrust upon the manufacturer, these requirements have many times in the past resulted in poor location decisions. It is not unusual in such situations to find that some minor criteria swayed judgments to a measure far beyond that factor's locational import and led to an unsound operation.

Labor

Unless modified by marketing considerations which demand over-the-fence service or close alignment with contracting authorities, labor occupies the predominant position in the hierarchy of locational elements.

Labor Supply

Numbers and characteristics needed by manufacturers must both be present to assure an adequate supply. Larger plants needing 1,000 or more workers would prefer at least 3 applicants for each position to assure in-plant training potential. For this reason, they will often gravitate to metropolitan areas.

Since males make up the larger part of the work force, less of a cushion is required for turnover and absenteeism. Potential for in-plant training manifests itself because of the general shortage of skills. Companies have to run their own schools for aircraft assemblers, welders, tool and die makers, and machinists.

Smaller companies locating in less populous communities experience greater difficulty in meeting their skilled manpower requirements, but some have achieved remarkable success by importing skilled machinists, etc. from major manufacturing areas at nominal salary increases and by granting limited authority or prestigious privileges. Unskilled labor supplies are generally more than adequate. In these situations a trade-off has been made for overall wage benefits at the expense of tightness in the skilled labor category.

Yet, this approach is not common, and many firms will hesitate at this type of trade-off. However, some larger companies when employing the cluster concept work a related method. Because of its larger resources the company can institute long-range training programs to augment its cadre of transferees.

Investigations of labor supply cannot be conducted in a wage vacuum. Areas may show a limited labor supply when only those unemployed or not participating in the labor force are considered. But many job holders may be underemployed, working in an industry with wage rates lower on the wage ladder.

When "cost plus fixed fee" contracts were in high style, considerable pirating would take place because of the aircraft parts industry's wage flexibility. Wage levels in the industry remain among the highest, and aircraft parts firms still possess considerable wage rate leeway in meeting competition for labor from outside the industry. This is 1 reason why 1 firm in a relatively labor short market could plan a 30 percent increase in its staff and succeed in finding the necessary 1,400 workers.

Labor Costs

Among the variable geographic costs, labor exercises a strong locational pull. Although the greater percentage of white collar workers in the industry today (see Section III) contributes to the mitigation of this regionally variable factor, especially when compared to the staffing needs of the early 1950's, comparative advantages still lie within alternate areas.

Regional differentials hover around 9 percent. For a plant employing 1,000 production workers, a shift in manufacturing location could amount to a $550,000 annual wage saving. Variations in fringe benefits would add another $150,000 in savings for a total labor related advantage of $700,000 per year. Depending on the location of principal customers the amount could account for up to 30 percent of a region's competitive advantage.

However, the estimated savings presuppose a reasonable plant orientation to market. In the example cited, an east coast plant attempting to ship 85 percent of its output to Seattle, Washington would see its labor advantage eaten up by increased transportation costs.

The achievement of a labor cost advantage is generally difficult. The industry is organized by both the United Automobile, Aerospace and Agricultural Implement Workers of America, and the International Association of Machinists. Choice of organization by either of the unions presents little in the way of alternate advantage to the companies, since similar bargaining objectives by the unions are developed jointly in advance of negotiations.

More to the location point, perhaps, may be a clause in the bargaining agreement analogous to the following: "If, during the terms of this agreement the Company establishes or operates a new plant, the Union will make written claim, and the company will recognize the Union as the exclusive bargaining representative for employees at such new plant..." Obviously, in these special cases only a minor wage differential, at best, would be permitted. Over a short period, possibly 2 bargaining sessions, the differential would evaporate. Under this set of rules the location parameters change abruptly, and labor costs are relegated to a minor position in the location equation. Nonetheless, qualitative labor considerations will continue to occupy an important judgmental position.

Since locations within or near higher cost metropolitan areas are necessary on many occasions, another constraint is placed on the opportunity for broad regional wage differentials. Furthermore, as pointed out earlier, many shipments are made over large distances, resulting in comparatively high shipping charges. Also, new contracts often mean new customers far removed from the present locus of operation. Transportation of finished goods to these customers further raise delivery charges. As a result of these influences, wage rate differentials do not weigh as heavily in the aircraft parts industry as in many other manufacturing enterprises.

Transportation Costs

Inbound freight costs present little in the way of geographical cost differences. Many of the raw materials are shipped FOB destination or are "delivered priced."

Outbound transportation costs do not always lend themselves to quick interpretation. Contractual terms may delineate contractor responsibility to FOB shipping point. At other times, the negotiated price will include the cost of shipping by the contractor to the aircraft or missile assembly plant. Shipping costs may or may not enter into the price calculations. Nevertheless, the parts builder finds that outbound costs can and do enter his profit picture from either side of the ledger.

In a large number of cases, it is advisable to treat the costs of outbound shipments as through borne entirely by the seller. This is particularly true where costs rather than a unique manufacturing capability determine the contract award. Yet, it must be remembered that today prime contracts are tied more closely to performance, especially with the heavy emphasis on "zero-defects," and price considerations become relatively flexible.

Bulky airframe sections not only entail additional handling, but in many cases move on more expensive LTL ladings. On occasion, common carriers will pass up such parts unless they get some matching profitable business. Industry-operated private motor carrier operations may enter the script, but often at greatly expanded costs. Truckload shipments of "clean" merchandise are the least troublesome and entail the lowest transportation charges.

Outbound transportation costs will vary widely. Sometimes they will account for 10 percent of location differences when comparisons within regions are made. At other times they can jump to 60 percent or more. A major determinant is the contract and the place of delivery. For example, 1 eastern plant is currently delivering parts at an annual shipping cost of $340,000.

A new contract for an equivalent amount of parts to be sent to a west coast aircraft assembly area will jump outbound transportation charges to $2.1 million. Referring back to a previous citation where an annual labor cost advantage of $700,000 was shown, the new transportation differential of $1.7 million will completely nullify the wage advantage during the life of the new contract.

Community Amenities

Although cost benefits may accrue to a firm employing 100, more or less, by locating in a smaller community, technical staffing requirements might prohibit such a move. The ratio of technicians and engineers to production workers displays an industry-wide increase (see Section III). Preferences of hard-to-get (and often hard-to-hold) technical employees must be given careful consideration. The amenities of life take precedence over a baneful existence.

Nevertheless, many companies have shown that access to the amenities is the real measure, and a location in the midst of a metropolitan area does not constitute a necessity. Commuting times are relative and can be compared, while distances in terms of miles may bear little weight.

After the general area of location is established and the manufacturer turns a sharper focus on individual communities, factors such as the quality of the town's school system or school systems in neighboring locales bear careful evaluation. Community appearance and utility services, local tax rates, and availability of police and fire protection undergo closer scrutiny. Although point systems of comparison are often given publicity in the popular press--and even in commercial publications, the qualitative nature of the evaluation applied to most of these factors points up the naivety of such an approach. More commonly, each factor elicits a "go-no go" decision. Items subject to a quantitative analysis, but yielding minor cost differentials, can be balanced against the survivors.

Sites

Tracts with rail sidings and oriented to highways are a major consideration. Large acreage is also generally demanded. No unusual site demands present themselves, although commercial airport facilities nearby will enhance the competitive position of a parcel thus served. With commercial air service close by, improved communication and liaison with other company plants and customers accrue. For some manufacturers air service is a necessity. Large power demands will also be made, but the loads are not unusual for a site servicing a large manufacturer.

Occupancy Costs

The range of occupancy costs, including amortization, heating, and taxes will range slightly between regions, but generally amount to less than 3 percent of the total variations. Often when the search localizes to a metropolitan area and its environs, sizable tax differences will crop up and influence a location among surviving communities. In this arena of local tax differences, "incentives" frequently distort the best approximation of comparative personal and real property tax impact.

The influence of comparative state labor laws, and use taxes and imposts on inventories comes into play at the time of final community selection. Much leeway continues to exist at this point without disturbing major cost advantages. A final selection among 6 communities in 3 different states is not uncommon. States with particularly onerous tax policies would be eliminated at this juncture.

Other Considerations

Financing:

A competitive factor in final community selection.

Ancillary Industries:

Frequently needed for unique metal forming. However, not necessarily in the same community. Specialized metalworking operations often take place 200 miles from the parts fabricator.

Vocational Training Facilities:

Will count heavily in final area selection. The existence of facilities are not enough. The history of industrial cooperation and record of achievement as reported by other local manufacturers will shape much of the evaluation. In-plant training will augment vocational education.

Utilities:

No unusual demands will be placed on local utilities. It is assumed, however, that the available site presents adequate water and sewer services

Miscellaneous:

Selection of vendors, lead time in placing orders, the role of "make-or-buy" decisions, and short- and long-term financing for operations play little or no part in the location problem. Although relegated to the miscellaneous grouping, the need for close liaison with customers and advanced engineering training facilities are not always a requirement. When they are necessary to assure the operation of a planned facility, only areas offering these advantages can receive consideration.

Summary

Among geographically influenced cost factors, transportation accounts for the largest variation. Yet, to orient a plant to the market presents major difficulties because wide shifts in product destinations occur during succeeding periods of time. Although broad regional wage differentials are constrained, wage costs do, at times, account for the largest interarea cost differences.

The basic requirement of a skilled or trainable labor supply in a locale large enough to accommodate employment fluctuations cannot be ignored and is illustrated by the subassembly manufacturing plant under construction near Charleston, South Carolina. As mentioned before, labor cost differences account for a sizable, although not always major, interregional expense difference. Nonetheless, the labor advantages maintain a semblance of stability over a period of time not wielded by transportation. Thus the supply, characteristics, and cost of labor becomes the most important locational criteria.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

This industry presents the most concrete and direct opportunity for Federal Government action to reverse the long-term stagnant economic condition of the overall Appalachian Region.

Prime Government Contracts and Subcontracts

A twofold purpose, that of defense plant dispersion and economic revitalization of the area would result from a concerted drive to steer space and defense aircraft production to a selected number of areas in Appalachia. The impact of defense contracts on the aircraft industry is well documented. Activity during the Second World War, the Korean conflict, and now during the Vietnam action has stimulated a vast west coast industrial complex. In more recent years, comparable activity in missiles has flowered Cape Kennedy, Huntsville, and Houston.

The effect on strategically located Appalachian communities could exceed these earlier successes. The industrial activity stimulated in Appalachia would rest permanently on major markets in the private economy. The 2 largest industrial markets in the world fall to both the east and west of the Appalachian Region. There is probably no other area so strategically placed and that has such overwhelming potential to develop from the impetus of DOD and NASA contracts awarded to companies which will locate and operate their facilities in Appalachia.

A glance at shipments of defense-oriented aerospace industries in 1963 (see Table 13) shows that directing defense orders to a selected area would not be precedent making. The dearth of activity in Appalachian states is also pointed out in the chart, particularly when data for areas such as Baltimore, Maryland; Columbus, Ohio; Schenectady, New York; Atlanta, Georgia; and Huntsville and Birmingham, Alabama are removed from the state tabulations.

Table 13.

Value of shipments, defense-oriented aerospace industries 1/

	Value of shipments ($ million)
United States	$15,941.2
California (all counties)	5,310.7
Los Angeles County	3,434.7
San Diego County	565.4
Alabama	155.1
Georgia	200.0-499.9
Kentucky	-
Maryland	214.9
New York	1,062.5
North Carolina	40.6
Ohio	943.3
Pennylvania	405.4
South Carolina	1.0- 1.9
Tennessee	50.0- 99.9
Virginia	-
West Virginia	2.0- 4.9

1/ Source: 1963 Census of Manufactures.

Note: Government shipments in aerospace amounted to 86.5 percent of the value of shipments for Defense Oriented Aerospace Industries.

Another graphic illustration of defense contracts in the aerospace industry, where they are directed, and the need for increased awards in Appalachian states appears in Table 14 below.

Table 14.

Unclassified defense and space contracts for 1964 - industries SIC 3721, 3722, 3723, and 3729 1/

Area, region, or state	Unclassified prime military contract awards
United States	2,580,920,000
California (all counties)	374,665,047
Los Angeles County	307,011,467
San Diego County	11,954,970
Appalachian Region	
Alabama	21,294,828
Georgia	0
Kentucky	0
Maryland	790,268
New York	4,261,809
North Carolina	723,098
Ohio	0
Pennsylvania	2,415,407
South Carolina	0
Tennessee	1,162,644
Virginia	0
West Virginia	28,371
Total Appalachian Region	30,676,425

1/ World Friends Research Center, Inc., Walter Isard and Gerald Karaska of the Wharton School, University of Pennsylvania, Philadelphia, Pennsylvania.

Following up the contract awards would be a concerted effort to materially upgrade selected areas through federal and state sponsored programs. Again the precedent exists at Oak Ridge, Tennessee and Hanford, Washington. In addition, as repeatedly pointed out at the Vice President's Conference with City Managers on July 28-29, 1966, many of the tools already exist.

The International City Managers' Association, reporting on the 2-day conference, summarized the federal aids available as detailed by the representatives of the 15 participating federal agencies including the Executive Office of the President, represented by David L. Lawrence; the Department of Housing and Urban Development, Robert Weaver and H. Ralph Taylor; Department of Commerce, John T. Connor, Rex M. Whitton, and Benjamin Chinitz;

Department of Justice, Nicholas deB. Katzenbach; Corps of Engineers, Brigadier General W. P. Leber; the Departments of Agriculture, Labor, Interior, Health, Education and Welfare, and other offices, even the State Department. All have programs that could be coordinated to implement an economic renewal in Appalachia, anchored in the favorable balance of trade brought about by the defense contracts awards.

Other supporting activities are tabulated below.

Table 15.

Aircraft and aerospace parts industry supporting public investment activities

	Importance of Activity		
	Major	Variable	Unimportant
Highways & access roads	X		
Rail	X		
Waterways transportation			X
Air transportation		X	
Land use planning		X	
Land stabilization			X
Conservation & erosion control			X
Forestry development			X
Vocational training facilities	X		
Technological resources		X	
Public health programs		X	
Pace & timing of commodity planning efforts		X	
Flood free sites	X		
Serviced sites	X		
Utility services	X		
Processing water			X
Recreational facilities		X	

Appendix A

SELECTED INFORMATION SOURCES

Published Information

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(5) Interindustry Employment Requirements, July 1965, Monthly Labor Review, Bureau of Labor Statistics, United States Department of Labor.

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(10) Road Maps of Industry, May, June, and July 1966, National Industrial Conference Board, New York.

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(19) Unclassified Defense and Space Contracts, 1964, World Friends Research Center, Inc., Philadelphia, Pennsylvania.

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(22) Missiles, Spacecraft and Aircraft, 1963, Bureau of Employment Security, U.S. Department of Labor.

(23) Reports, Aeronautic and Space Engineering and Manufacturing Meeting, October 1966, Society of Automotive Engineers, Inc., Los Angeles, California.

(24) Census of Transportation, 1963, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

Unpublished Information and Personal Contacts

(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(5) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:
REPORT NO. 16--THE PRIMARY ALUMINUM INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such industry, specifically, Standard Industrial Classification industry code 3334, Primary Aluminum.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

The production of primary aluminum provided employment for 20,295 people in 1964, with value added by manufacture topping $548 million. The metal's unique properties have fostered increasing acceptance in a wide variety of markets. Building and construction and transportation markets share equally in over 46 percent of the total output.

Currently, 8 firms are operating 24 establishments in producing primary aluminum. While the industry's leader claims 35.6 percent of the total capacity, the second and third largest firms add another 49 percent. Not less than 16 establishments employ over 500 and 6 are in the "over 1,000" range.

Although 13 states have a share in aluminum production, only 6 of these can boast of more than 1 plant. In terms of capacity, the Gulf Coast and Pacific Northwest lead with 29 and 28 percent, respectively. The Ohio River Valley follows with 18 percent. Appalachia includes 4 plants, located in Alabama, Tennessee, Ohio and West Virginia, with 24.3 percent of current industry capacity.

A measure of economic impact is derived from the industry's newest addition. This plant, to employ 900 at full capacity, is said to represent $55 million annually in new income within the state.

Industry growth prospects are extremely bright. Annual growth has averaged 10 percent over the past 4 years, with each year establishing a new production record. The year 1966 is expected to yield yet another record, furthering production by 7 to 12 percent.

At the present time, the industry is operating at over 100 percent capacity, and there is a general shortage of supply. Plans for new investment are extensive and provide for the addition of 1.1 million tons per year by 1970. Employment is expected to continue its growth with the addition of this capacity.

Power costs and total transportation expenses provide the primary and inflexible determinants for the location of new facilities. The latter emphasizes the new degree of market orientation. The benefits of waterway transportation have become of increased importance as the industry strives to improve profits while operating with a pricing structure established in the early 1960's.

The industry cannot exist without first class rail service and access to a primary highway system. Other important requirements include sites of large acreage, natural gas service, a labor supply conducive to long-term economical operations, an equitable tax structure at the state and local level, and community amenities which will assist in attracting and retaining qualified professional and management personnel.

Areas for effective public investment designed to enhance the overall competitive position of Appalachia will emphasize the development of low-cost power supplies, improved transportation facilities, more extensive vocational education, and the pace, timing, and direction of community improvement programs.

I. PROFILE OF THE INDUSTRY

Size

The production of primary aluminum accounted for 1.7 percent of manufacturing employment for all primary metals, 3.3 percent of the value added by manufacture and 2.7 percent of the new capital expenditures generated by the overall industry in 1964. These data, in more absolute terms, are compared with all other durable goods manufacturing in Table 1.

Table 1.

Rankings of the durable goods industries, 1964 1/

(Numbers in millions)

Industry rank	Employment		Value added by manufacture		Capital expenditures	
1	Transportation equipment	1.62	Transportation equipment	$23,971	PRIMARY METALS	$1,887
2	Machinery	1.54	Machinery	19,762	Transportation equipment	1,297
3	Electrical machinery	1.48	Electrical machinery	18,039	Machinery	946
4	PRIMARY METALS	1.18	PRIMARY METALS	16,732	Electrical machinery	889
5	Fabricated metals	1.12	Fabricated metals	12,636	Fabricated metals	728
6	Stone/clay/glass	.58	Stone/clay/glass	7,520	Stone/clay/glass	626
7	Lumber/wood	.56	Lumber/wood	4,361	Lumber/wood	369
8	Furniture	.39	Instruments	4,333	Instruments	165
9	Instruments	.31	Furniture	3,225	Ordnance	117
10	Ordnance	.23	Ordnance	2,871	Furniture	106
	PRIMARY ALUMINUM	.02	PRIMARY ALUMINUM	549	PRIMARY ALUMINUM	52

1/ Source: 1964 Annual Survey of Manufactures, U.S. Department of Commerce, and Fantus Area Research estimates

As measured by the 1964 Annual Survey of Manufactures, primary aluminum expended $653 million for materials, producing shipments worth close to $1,191 million in that year. Actual employment was 20,295 and value added by manufacture ran to $548.8 million.

Products and Markets

Primary aluminum presents a unique combination of properties. It exhibits lightness, good thermal and electrical conductivity, high reflectivity, malleability, resistance to corrosion, and tensile strength in alloyed form. These have fostered an increasing acceptance in a wide variety of markets formerly reserved for or dominated by other materials.

Aluminum marketed in 1965 went to the following user industries:

	1965 Tonnage	Percent of total shipments
Building and construction	933,500	23.5
Transportation	924,000	23.2
Electrical	540,000	13.6
Consumer durables	421,500	10.6
Containers and packages	328,000	8.2
Machinery and equipment	235,000	5.9
Exports	237,000	6.0
Other	360,000	9.0
		100.0

Penetration of the building and construction field has doubled over the past 10 years and now provides the largest single outlet. In new home construction, the average single-family unit presently contains 300 pounds of aluminum--an increase of 220 pounds since 1955.

Transportation markets now approach the building and construction volume. After a decline in the 1955 to 1958 period, this market grew fourfold rising from 10 to 22 percent of the total shipments. The average 1965 automobile contained three times the aluminum of models 10 years earlier--an amount now equal to 74 pounds. Military aircraft consumption is running at one-third of the Korean War levels; however, the metal is finding increasing markets in heavy-duty truck and railroad car manufacture. A pound saved in equipment frequently can add a pound of revenue freight, and operators benefit from lower maintenance costs.

Consumption by the electrical industry doubled from 1960 to 1965 and now claims 13 percent of aluminum shipments. Wire cables and conductors are the largest single electrical market. Properties of conductivity and weight are enhanced by the metal's relatively low cost. From a conductivity viewpoint, aluminum requirements are one-half (by weight) of copper and, at today's prices, an equivalent conductor made of the latter material would cost 3 times that of aluminum.

New applications in all three major markets indicate that they will continue to dominate the demand on capacity, barring unforeseen additional military requirements.

Plant Ownership and Size Structure

As of the first quarter of 1966, the industry's leading firm controlled 35.6 percent of domestic primary aluminum capacity. The second and third largest companies control about equal parts of capacity and combine with the leading manufacturer to account for over 84 percent of U.S. capacity. Currently, 5 other firms make up the balance of production with prospects good for the addition of another producer in the relatively near future.

Census statistics from 1963 indicate a total of 7 companies operating 23 establishments. One new producer has just started operation in Bellingham, Washington. Of the 23 establishments, 1963 employment fell into the following ranges:

Number of establishments	Employment range
1	1-19
1	20-49
5	250-499
10	500-999
6	over 1,000

Geographic Prevalence

Establishments producing primary aluminum are found in 13 states. Only 6 states can claim more than 1 plant within their borders, as shown in the following table:

Table 2.

Regional distribution of establishments 1/

State	Number of plants Employing over 500	Total
New York	2	2
Ohio	1	1
Indiana	-	1
West Virginia	1	1
North Carolina	-	1
Tennessee	1	2
Alabama	1	1
Arkansas	1	2
Louisiana	1	1
Texas	3	3
Montana	1	1
Washington	3	5
Oregon	1	2
Total	16	23

1/ Source: 1963 Census of Manufactures

When based on capacity, the Gulf Coast and Pacific Northwest claim 29 and 28 percent, respectively, while another 18 percent is found in the Ohio River Valley.

Appalachian Specialization

Appalachia numbers 4 plants within its borders, with locations in Alabama, Tennessee, Ohio, and West Virginia. Production capacity exceeds 670,000 tons per year--an amount equal to 24.3 percent of current capacity. Moreover, the four states share relatively equally in this production.

Economic Impact

The experience in the Pacific Northwest amply demonstrates the economic impact of primary aluminum. In 1964, the industry there paid out $65.3 million in wages and salaries. An additional $134.6 million went to freight, electric power, materials and supplies, taxes, and additions and improvements to plant and equipment. The recently dedicated new facility in Washington was said to represent $55 million in new income for the state. For every worker employed by primary producers, there are 3 in the region producing finished aluminum products. Moreover, analysis of interindustry employment requirements indicates that slightly more than an equal amount of indirect employment is required to support a new facility.

A further indication of the industry's impact can be derived from analysis of the interindustry (input-output) tables. Purchases from direct suppliers are related to $1,000 of primary nonferrous metal industry gross output in Table 3.

Table 3.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from other establishments	Primary nonferrous metals manufacturing
Nonferrous metal ores mining	$ 79.06
Chemicals & selected chemical products	9.69
Plastics & synthetic materials	11.21
Primary iron & steel manufacturing	11.83
Primary nonferrous metals manufacturing	303.57
Stampings, screw machine products & bolts	9.29
Other fabricated metal products	10.64
Metalworking machinery & equipment	7.14
Electric lighting & wiring equipment	5.51
Transportation & warehousing	21.53
Electric, gas, water & sanitary services	21.48
Wholesale & retail trade	33.87
Finance and insurance	7.09
Business services	7.74
Gross imports of goods and services	85.41
Other industries	92.90
Total purchases	717.96
Value added	282.04
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

The attraction of primary aluminum for other manufacturers can be demonstrated from experiences in Appalachia itself. Hot metal transfers from the Alabama plant feed the casting line of a major auto parts producer. In Tennessee, aluminum production has attracted an establishment specializing in the repair of electrical coils. Huge demands on mechanical and electrical apparatus foster the development of nearby repair and service facilities.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Consumption

A sevenfold increase in capacity during World War II left the industry with a substantial excess at the war's end. By 1946, production had dropped sharply to 410,000 tons from the 1943 capacity of 1,164,000 tons. Government plants were shut down and a large inventory threatened to hang over the market for years.

In 1950, at the start of the Korean War, capacity was at 750,000 tons. An Office of Defense Mobilization program provided for 5 year accelerated write-offs together with a 5 year guaranteed purchase commitment, inducing an 85 percent rise in capacity by 1954. A continued demand and optimistic viewpoint of industry added another 79 percent increase by 1960, taking capacity to the level of 2.5 million tons. However, decreased military requirements and a business recession resulted in a falling off in demand and the industry was plagued with over-capacity. Prices fell 3.5 cents per pound between 1958 and 1962. Net earnings fell from $174 million in 1956 to $88 million in 1960.

Demand finally caught up in 1960, and the industry proceeded into four consecutive years of record sales and production. The annual growth rate for production has averaged 10 percent over the past four years. The year 1966 is expected to claim another record furthering production by 7 to 12 percent. The price of ingot was raised 4 times between October 1963 and November 1964.

Today's total installed capacity lies at 2.936 million short tons per year. An addition of 1.1 million tons per year by 1970 is planned by the industry, expected at a compound annual growth rate of 6.7 percent. In 1965, pourings ran to 2,754,000 tons--an amount exceeding 100 percent of rated capacity. This year, output is running 8.1 percent ahead of 1965 due mainly to a plant addition in Evansville, Indiana and the opening of a new 70,000 ton per year plant in the Pacific Northwest. Demand is rising rapidly, and the primary domestic supply required augmentation from 3 principal sources: (1) secondary (recovered) aluminum now accounting for close to one-fifth of domestic consumption and limited mainly to casting; (2) releases from government stockpiles; and (3) a rapid rise in imports, up 32 percent over the 1965 level.

Table 4 presents a historical picture of domestic primary aluminum. Industry experts are unanimous in predicting a demand of over 4 million tons per year by 1970.

Table 4.

Domestic primary aluminum data

(tons)

	Production 1/	Shipments 2/
1964	2,552,747	2,555,120
1963	2,312,528	2,353,624
1962	2,117,928	2,184,857
1961	1,903,711	1,956,168
1960	2,014,498	1,866,250
1959	1,954,112	1,987,467
1958	1,565,557	1,590,978
1957	1,647,709	1,579,063
1956	1,678,954	1,591,478

1/ Source: The Aluminum Association

2/ Source: American Metal Market

The section of this report entitled "Product Innovation and Interproduct Competition" will demonstrate the growth potential for some of the more rapidly growing markets. The ability of the industry to satisfy the more near-term demand must rest on the extent of purchases for military commitment. Currently, the supplies are sufficient to meet the government "set-asides", a priority system--not stockpiling--giving assured access to a fixed portion of industry output. These requirements average about 18 percent of total capacity in 1966. Approximately 10 percent has been going into war production. Actual "set-aside" requirements were established as follows:

Quarter	Year	Short tons
3	1965	24,500
4	1965	100,000
1	1966	107,500
2	1966	130,000
3	1966	145,000
4	1966	150,000

As a result of Viet Nam, the current tight supply picture has been projected well into 1967.

Profits

From an industry-wide low point of $88 million net earnings in 1960, the industry has made substantial progress in improving its profit position. Net income for the 3 leading producers alone ran to over $165 million in 1965. Profits for the first quarter of 1966 were 40 percent above the similar year-earlier figure--gained, no less, at prices established in the early 1960's. The following table indicates the 1965 profit ratios for the 3 leading firms in the industry as well as one of the smaller producers:

Table 5.

Profit ratios of the primary aluminum industry, 1965 1/

Company	U.S. production capacity as a percent of total	Net income on net sales (percent)
A	35.6	6.49
B	25.8	7.12
C	23.1	6.45
D	3.1	5.58

1/ Source: Company financial statements

In November 1965, the industry attempted a 0.5 cents per pound price increase. This was quickly rolled back under White House pressure and threat of substantial releases from government stockpiles. An agreement was reached whereby the industry would purchase the stockpiled metal in an orderly fashion--at least 150,000 tons by the end of 1966 and between 100 and 200 thousand tons each year thereafter. Within the first 10 months, the industry had drawn out more than 220,000 tons.

In an attempt to raise profits, however, the industry moved further into the production of fabricated items and eliminated the traditional, although unpublished, discounted pricing structure.

Now that the stockpile position is under control, and the wage-price guide lines have been fractured, many think that the price increase will be reinstated within the next 12 months.

Employment

Employment figures for the primary aluminum industry reflect to a large extent the rather erratic growth experienced by the industry. Significantly, the employment turning point of 1961 parallels the upswing in production. A consistent growth pattern since that time provided a 25.3 percent overall increase in employment (see Table 6). Recent additions to capacity as well as extensive expansion programs indicate that the trend will continue into 1970.

Table 6.

Employment in the primary aluminum industry 1/

Year	All employees	Production workers	Production worker man-hours (1,000)
1956	21,120	17,046	34,752
1957	20,500	16,327	33,430
1958	17,381	13,428	27,738
1959	17,997	14,362	30,022
1960	17,848	14,120	29,133
1961	16,201	12,651	26,087
1962	17,221	13,677	27,924
1963	18,133	14,459	29,487
1964	20,295	16,670	31,952

1/ Sources: 1963 Census of Manufactures
1964 Annual Survey of Manufactures

Investment and Locational Activity

With the problem of excess capacity completely overcome in 1965, virtually all existing manufacturers, and some new entrants, are in the midst of or planning for additional capacity. Much of this will take the form of added potlines at existing facilities. Some will mean new establishments. Indications are that 3 or 4 new plants will appear on the domestic scene prior to 1970.

In the period between 1958 and 1963, the industry added no more than 3 plants. One of these employed under 20 and the other two fell in the 250-499 employment range.

Industry investment plans call for the expenditure of $2 billion by the end of 1970. In addition to existing producers, 3 new entrants have appeared on the scene. One operates the recently opened facility in Bellingham, Washington. With 76,000 tons per year on stream now, plans call for a total of 228,000 tons of capacity by December 1968.

A second new firm, like the first a joint venture of American and foreign interests, has announced a facility to be located near Puget Sound in the Pacific Northwest. To be completed in 1969, the 140,000 ton plant will ship one-third of its ingot to Japan.

The third newcomer, a newly established Georgia company, has announced intentions of constructing a $38 million establishment "somewhere in the Southeast". Construction is scheduled to start in the spring of 1967, to be completed in early 1969. Production of 132,000 tons per year is expected within 10 years.

Another potential, although several years away, is a $70 million, 100,000 ton per year facility designed to serve the requirements of a new 60,000 ton rolling mill now under construction in Kentucky. Still another possibility involves a similar situation in Alabama.

Virtually all of the major producers have extensive expansion plans under way. Announced programs involve expanded capacity in New York, Ohio, Indiana, Washington, Oregon, Montana, and North Carolina, among others. While the Pacific Northwest figures heavily in these plans, leading industrialists have stated that the area has reached its peak capacity for cheap hydroelectric power and that, for the foreseeable future, primary expansion in the Northwest has come to an end.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

The current process of converting alumina to aluminum remains virtually unchanged from that invented by Charles Martin Hall in 1886. There have been refinements, of course, but the process still employs a carbon-lined vessel containing molten cryolite in which alumina is dissolved. The cryolite is usually produced synthetically from alumina, soda, and hydrofluoric acid.

Today's electrolytic cells, or pots, are large shallow carbon-lined steel tanks, and produce 800 or more pounds of aluminum a day. As they operate at low voltage, long rows of pots (thus the term "potlines") are connected in series for group operation at higher voltage.

As the electric current flows through the molten solution of alumina, aluminum is electrolytically separated and deposited on the bottom of the pot. Oxygen is liberated at the carbon anode where it forms carbon dioxide and escapes. There is little reaction in the cryolite although it must be replenished occasionally. Fresh alumina is fed into the pot from time to time. The process is a continuous one, operating 24 hours a day, 7 days a week.

Metal is removed from the pot by siphoning into large ladles which move directly to the casting line.

The carbon anode is consumed at a rapid rate in the process (0.6 pounds per pound of alumina) and must be replaced. The cell design permits this without interruption of the continuous process. Most modern reduction plants make their own carbon anodes from a baked mixture of petroleum coke, pitch or specially prepared anthracite coke, and a suitable binding agent.

The industry's newest plant boasts the lowest operating costs yet, aided by a new innovation which allows a 25 percent reduction in power requirements and the industry's highest capacity potlines. Other manufacturers will quickly move to take advantage of the lower power requirements. The advent of nuclear power holds out another, even greater, potential for lowering the cost of power and at the same time allowing profitable production at virtually any site.

Raw Materials

The production of 2,000 pounds of aluminum requires the following approximate quantities of raw materials:

Alumina	4,000 pounds
Carbon paste	1,300 pounds
Cryolite	50-60 pounds
Alumina fluoride	70-80 pounds
Electric energy	20,000 kilowatt hours
Labor	30 man-hours

To produce the 4,000 pounds of alumina required, 8,000 pounds of bauxite is necessary. Most bauxite is imported from Surinam and Jamaica. The current trend is to refine the bauxite at mine site thus incurring shipping charges on the lower-weight alumina. Much of the bauxite, however, is processed only to the extent necessary to reduce the moisture content and is shipped to Gulf Coast processing plants for conversion into alumina.

Manpower Utilization

Productivity in primary aluminum production has increased steadily. Table 7 summarizes data published by the Bureau of Labor Statistics:

Table 7.

Productivity in primary aluminum 1/

	Average annual rates of change (percent)	
	1947-63	1957-63
Output per man-hour		
All employees	5.5	7.8
Production workers	5.9	7.7
Man-hour unit labor requirement		
All employees	-5.2	-7.3
Production workers	-5.6	-7.2

1/ Source: Bureau of Labor Statistics

Female representation in the labor force generally falls below 5 percent. Major plants vary in size from 400-500 workers to over 6,000. Skills required run the broad range from common labor to sophisticated mechanical and electrical skills and chemical plant operators. Automation took a heavy toll in the late 1950's and early 1960's; however, with the announced additions to capacity, industry employment opportunities are expected to increase rapidly over the next 3 years. The industry's newest plant will employ 900 workers in the production of 228,000 tons of aluminum annually.

Product Innovation and Interproduct Competition

As a relative newcomer in the field of primary materials, aluminum has been forced to carve out markets in areas formerly dominated by other metals. It came well equipped for the task with a broad array of properties in a rather unique combination (see Section I, Products and Markets). In many markets (e.g., aviation, kitchenware, building materials) aluminum is well established. In many others, already utilizing substantial amounts of the metal, current prospects hold out a large potential for increased consumption.

Aluminum is replacing steel to a large extent in the construction of electrical substations and transmission towers. Although more expensive, they involve less maintenance and are easily erected (by helicopter if necessary). Since electrical utilities are now in the midst of combining individual networks into regional power pools, this application has a new multi-billion dollar potential over the next 10 years.

New inroads are being made in can containers, although steel is moving to protect this $2.2 billion market. Aluminum made its first move about 5 years ago, providing containers for frozen citrus fruits. Now, solf-tops, pull-tops, and all aluminum cans are becoming increasingly common.

Another new product is found in a recently developed hangar for private planes. Made with aluminum, the structure can withstand 100 mile-per-hour winds and is light enough to be moved intact with a 2-ton truck.

On the whole, aluminum is competing with other materials for almost every application. Aluminum sheet opposes galvanized iron and steel sheet. Electrical conductors are made from copper or aluminum, as is transmission cable. Aluminum castings are in competition with magnesium, zinc, steel, iron, copper, and plastic shapes, while foil competes with paper, plastics, lead and tin.

Aluminum has been successful not only due to its versatility but also because of its price trend relative to that of other materials. In the past 2 years, a severe shortage of copper has substantially assisted aluminum. Moreover, in applications where aluminum is still at a price disadvantage, it is nonetheless widely adopted due to other features such as ease of fabrication, low maintenance, and/or reduced transportation expenses.

Imports of the metal are shipped primarily from Canada, Norway and France. While they are not a significant element in the industry today, due to the current demand, it is noteworthy that these imports are frequently offered at lower prices even after a 1.25 cents per pound tariff.

Distribution

Aluminum is sold through company sales representatives, backed by extensive applications engineering support. Basic materials are sold under a standard "delivered" price arrangement regardless of origin or destination.

Plants of the Pacific Northwest will attempt to compete in the Eastern-Midwestern fabricated products market by shipping ingot cross-country for processing in the market area.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

Historically, new locations for primary aluminum producers followed the development of new sources for low-cost power. During World War II, activity was centered in the Pacific Northwest where vast supplies of cheap hydroelectric power were available.

In the 1950's, when the national power supply situation was bleak, activity gravitated to the Texas Gulf area and its abundant supply of natural gas. Additionally, this area benefited from proximity to both domestic and Caribbean sources of bauxite.

The growth of the industry then moved up into the Ohio Valley to take advantage of vast supplies of modern coal-fueled, steam-generated uninterruptible power. Mine-mouth generation provided substantial economies. Moreover, proximity to markets and available water transportation allowed lower inbound and outbound transportation costs.

Accordingly, power costs and total transportation expenses provide the primary and inflexible control over establishing new production facilities. Market orientation is measured by the effect on outbound shipping costs. Navigable waterways are important in reducing inbound shipping charges. Rail, highway, natural gas, and site considerations are also of importance.

Power Requirements

The industry's average power requirements per pound of product runs between 8.0 and 8.5 kilowatt hours. Older plants can use up to 10 kwhr and the newest facility, as noted earlier, requires only 6.0 to 6.3 kwhr. Although this latter number represents a 25 percent savings on the industry average, full production will still result in an annual consumption of 2.7 billion kwhr.

The Pacific Northwest offers the lowest power cost, averaging 2 mills per kwhr since 1939. Using this rate, the above facility would expend 5.02 percent of sales revenues or over $5.6 million annually for power alone. Rates in the Ohio River Valley and other producing points normally run between 4 and 4.5 mills per kwhr and at least double the costs indicated above.

Power costs are even more significant to other major manufacturers since it is doubtful that these producers have yet developed a cell design allowing for the 25 percent reduction in power requirements. It is expected that most will have such a design in the relatively near future.

To be competitive, new locations must offer power at a rate close to or below 4 mills. Modern coal-fueled, steam generating plants can minimize costs through mine-mouth operation. A nearby location for the aluminum facility will cut down transmission losses. Coal should be of low cost and high quality.

While the industry's leader generally produces its own power (occasionally selling to other users), the second largest firm relies on purchased energy. The company next in line both purchases and produces power, and most of the remaining firms rely solely on purchased electricity.

A plant built by one of these firms today might typically produce 150,000 tons per year. A requirement of 8 kwhr per pound of aluminum, supplied at 4 mills per kwhr, would involve an annual cost of $9.6 million or 13 percent of the unit's annual sales revenue. Thus, an eastern location for such a plant must produce savings in freight or other costs equal to $4.8 million if the plant is to compete profitably with a Pacific Northwest location. To compete with the newest facility and its reduced power requirements, the annual savings must run to $5.9 million.

Transportation

It has been estimated that close to 70 percent of the market for finished aluminum products falls within a 500-mile radius of a mid-Appalachian location. Thus, the Region is well positioned to offer transportation savings of substantial magnitude.

Analysis of transportation costs must consider both inbound and outbound shipments. In total, the plant producing 150,000 tons per year will require 450,000 tons of inbound materials (including 300,000 tons of alumina). The basic raw material, alumina, will most probably originate in the Gulf Coast area. Petroleum coke and pitch, cryolite, alumina fluoride, fluorspar, caustic soda (or soda ash and lime) and foundry coke or anthracite will come from the nearest source.

The costs of moving large quantities of alumina by rail or barge is difficult to pinpoint since the rate structure is affected by multiple car hauls and the existence of an alternate mode of transportation. However, it has been estimated that transportation of alumina represents 0.6 cents per pound of aluminum on movements between Baton Rouge, Louisiana and Ravenswood, West Virginia, and 0.9 cents per pound of aluminum between Mobile, Alabama and Evansville, Illinois. Comparable rail costs between the Gulf Coast and the Pacific Northwest run 1.2 cents.

Outbound shipping charges, based on serving the Detroit market, are as follows:

	Freight costs per pound of aluminum (cents)
Ingot:	
Pacific Northwest to Detroit	0.5
Ohio Valley to Detroit	1.3
Sheet:	
Pacific Northwest to Detroit	2.3
Ohio Valley to Detroit	0.5

Plants of the size under discussion can benefit from locations with access to the waterway system through savings of up to $1.5 million annually. Moreover, movement of alumina via covered hopper barges provides the added advantage of floating storage, while creating water-compelled rail rates.

Outbound shipments rely heavily on both rail and truck transportation. Accordingly, new locations will demand first-class rail service and nearby access to one or more major highways.

Raw Materials

A location's proximity to sources of raw materials is important mainly as a transportation cost consideration. Arkansas provides the only significant deposits of bauxite in this country and, thus, about four-fifths of the industry supply is imported from South America and the West Indies. Recently, some producers have been receiving alumina from Japan and Australia.

In essence, the vast majority of bauxite or alumina will enter the U.S. through Gulf ports. Newport News, Virginia presents an alternate route. New plants will prefer waterway connection with one of the primary receiving points.

Since the 3 leading producers (who control over 84 percent of production) are all integrated both backward and forward, the logistics of any one location will probably vary depending on the location of existing raw material facilities.

Site Requirements

Sites of 250 to 300 acres can satisfy most plants of the 150,000 ton range. As noted earlier, the site should be adjacent to or nearby a major highway, allow for economical installation of rail facilities and, preferably, be located on an inland waterway. A 9-foot channel is needed.

The site must be flood-free in order to receive consideration, and those requiring minimum development costs will be preferred. Low-cost power, or suitable resources allowing for its generation, should not be too far removed. Alumina, which must be kept dry and clean, will require storage space for about 60,000 tons.

Natural Gas

Plants of the size under discussion will use between 1,500 and 2,500 MCF annually, in the carbon plant and casting operations. It is also important in secondary processes such as rolling, casting, and extrusion.

While not a primary and inflexible locational determinant, proximity to a gas line would be economically desirable. Gas line installation charges in the area of $4,500 per inch per mile would mean an investment of $360,000 to run a 4-inch line a distance of 20 miles.

Gas rates are one of the least important of the geographically variable operating expenses.

Labor Considerations

As noted earlier, the industry's newest facility will employ 900 workers when reaching full capacity of 228,000 tons per year.

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The 3 leading firms in the industry are organized by either the International Union, United Steelworkers of America, or the Aluminum Workers International Union (AFL-CIO). Bargaining is conducted essentially on a national basis, although geographic wage differentials may be recognized.

Fringe benefit packages are extensive and, as might be expected, closely parallel that of the steel industry. Costs to the company are usually in excess of 80 cents per man hour. The full range of group insurance benefits, for both the employee and his family, is provided at company expense. In addition, there are 7 paid holidays, a vacation schedule that escalates up to 4 weeks after 25 years, and company-paid pension programs. Other benefits frequently include a Supplemental Unemployment Plan, cost of living allowances, and the extended (13 week) "sabbatical" leave program similar to that of the steel industry. Employees become eligible for the latter after 5 years of continuous service.

Wages paid to primary aluminum production workers would generally fall within the following for plants located in Appalachia:

	Departmental average hourly earnings
General plant - indirect labor	$2.95-$3.05
Mechanical department	3.35- 3.45
Pot rooms	3.02- 3.12
Carbon operations	2.96- 3.07
Cast shop - direct labor	3.00- 3.10
Mill operations	3.07- 3.17

Skill requirements bracket the broad range common to the production of primary metals. Plants within Appalachia operate with 24 to 28 separate labor grades reaching from the common laborer up to 4-Hi mill operators. Appendix A presents a representative listing of job titles common to the production of primary aluminum.

New locations will not be determined by the availability of a skilled work force. Rather, the primary emphasis will be placed on maximizing the long-term profitability of the proposed facility. Labor force, as a consideration, is secondary. It must, however, provide for harmonious labor-management relations and should exhibit qualities demonstrating a potential for long-term satisfaction with the area.

A study conducted by the United States Department of Labor (Bulletin No. 1261 "Labor Supply and Mobility in a Newly Industrialized Area") is available from the U.S. Government Printing Office and provides in-depth treatment of hiring objectives, trade-offs, and practices in establishing the Ravenswood, West Virginia aluminum facility.

In essence, the company was looking for 55 percent of their work force in the 25-to-35 age bracket, prior manufacturing experience, physical vigor, and intelligence. Ideally, these were to be combined with requisite skills and the highest possible levels of education. A high school education was preferred for hourly rated and clerical employees.

Of significance, 8 percent of the plant complement were employees transferred from other locations and most (80 percent) fell into the professional, technical, managerial, or supervisory categories.

Tests were applied to determine general intelligence and mechanical aptitude.

Generally speaking, age and education requirements were met; however, desired skills and industrial experience were lacking. Emphasis then reverted to determining the educability of prospective employees as indicated by their age, education, and test results. Significantly, the unemployed and underemployed did not constitute the most important labor source. A high wage industry with rigorous hiring standards, when located in an underdeveloped or depressed area, will have substantial attraction for experienced workers in other manufacturing and nonmanufacturing industries.

Operating experience at the above plant indicates general satisfaction with the work force. Productivity in reduction operations is unsurpassed in the company. Mechanical and electrical maintenance skills remain as the most problematical.

Training is conducted in-plant and relies heavily on company supervisory personnel and equipment manufacturer representatives.

State and Local Taxes

Because of the very large investment in plant and equipment, goods-in-process, and raw and finished material inventories, manufacturers will avoid areas where such items encounter local taxation, all other things being equal. This determinant must be considered as secondary in that the total variance between locales normally is not sufficient to offset the economics of other, primary factors of location.

Communities where taxation is restricted to real estate will be preferred, however, and the prudent location-seeker will attempt to analyze the long-term prospects for tax stability.

Other Locational Determinants

Many other factors enter into the locational decision for primary aluminum facilities. Most of these are impossible to measure quantitatively. All of these will vary in importance with the individual company, its specific operating objectives, and the executive charged with responsibility for locating the plant.

Due to the nature of the industry, most plants claim wage leadership within the area, and many represent the "dominant" employment influence. The need for liaison and communications with other plants is important and firm commitments will be expected, if (transportation or communication) facilities are lacking. Scheduled air service should be within a 45-minute drive.

The large number of professional managerial, technical, and supervisory personnel demand an area which provides a suitable environment for family living. Experiences in Ravenswood, West Virginia demonstrate the problems in attracting and retaining such personnel when adequate educational facilities, housing, and community services are not available. The company involved has been forced to subsidize schools, hospitals, and building programs--an added expense which can detract, substantially, from a given community's competitive position.

Aluminum plants generally follow no particular pattern in regard to community size. Ravenswood, West Virginia claimed a population of slightly over 1,300 at the time of construction. Another major Appalachian plant, however, lies at the doorstep of Knoxville, Tennessee with a population of over 180,000.

In general, community cooperation is extremely important and available supporting service, or ancillary industry, is considered a plus. Make-or-buy decisions are of little importance. Water quality, quantity, and disposal requirements are relatively easy to satisfy. The lack of police and fire protection services will not affect the locational decision.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

The significance of and requirements for highway, rail, waterway, air transportation, process and cooling water, and effluent disposal have been amply demonstrated in Section IV. Other factors have no appreciable role whatsoever in the aluminum industry's locational decisions, and public investment would have little or no attraction for the industry. These are land use planning, land stabilization, conservation and erosion control, forestry development, and management of forestry resources. Of course, flood-free sites are a necessity.

This section of the report will emphasize those remaining areas where public investment, policies and activities can be effectively applied to foster further development of the industry within Appalachia and will be discussed in their relative order of priority.

Power

An adequate source of stable, economical power shares the spotlight with total transport costs as the industry's primary locational considerations.

As noted in Section IV, a plant producing 150,000 tons of primary aluminum annually will consume about 2.4 billion kwhr during that period. To be competitive, power must be supplied as cheaply as possible--preferably below 4.0 mills per kwhr. Of significance, the TVA standard rate for large industrial consumption results in a cost of 4.139 mills per kwhr at a 100 percent load factor.

Accordingly, location on the TVA system is not, in itself, the answer. The industry is looking for even cheaper power. This can usually be satisfied through coal-fueled, steam-generated electricity located at the "mine-mouth", with bus-bar connection to the reduction facilities. Nuclear generated power holds out a further potential.

Power loads of the nature described above will rarely be accommodated with existing facilities. Power plants would have to be expanded or new facilities constructed. Obviously, plans for supplying power in the quantities required will be the subject of negotiations with local and state officials as well as utility companies in the area.

Four significant alternatives warrant consideration in satisfying the industry's power demands. These are:

1) utility company operation of a generating plant constructed and owned by the aluminum company--with sale of excess power to the utility company;

2) the utilization of standby power held by the utility company;

3) a joint venture between the aluminum company and the utility for the construction of facilities; or

4) the establishment of bus-bar rates if the new location is near existing power facilities.

The role of public officials and community action in the above can vary; however, the responsiveness of these forces could well determine whether a particular location will receive further consideration.

Transportation

The importance of transportation costs is also highlighted in Section IV. One major producer in Appalachia depends on rail movements for 60 percent of the total outbound shipments, with motor carriers claiming the balance. Manufacturers of primary aluminum cannot exist without direct access to both rail and highway facilities.

Waterway transportation provides a significant economic plus and is becoming increasingly important to new locational activity. The potential for water-compelled rail rates further enhances the low-cost and increased flexibility provided by this means of transportation. Manufacturers will look first to those areas with direct access to a 9-foot channel.

Scheduled air transportation must be readily available in order to maintain liaison and communications with other company facilities, vendors, and consumers.

Vocational Training

Although the industry relies heavily on in-plant training and apprenticeship programs, this area is felt to present a logical opening for effective public investment. The industry's hiring standards are high, paralleling their wage pattern. If Appalachia is to benefit from the new locational activity, it would do well to initiate immediately federal, state, and local actions designed to improve the overall educational level of the work force. As noted from the experiences in Ravenswood, West Virginia, the chronic unemployed and/or the uneducated workers will not be the ones to benefit from new aluminum industry employment opportunities.

In addition to raising the general educational level of the work force, vocational programs should be initiated which are designed to develop or foster a basic mechanical aptitude. As noted in Section IV, mechanical and electrical maintenance skills are a problem to the industry. Other course offerings that would be helpful include: instrument and electronic repair, stationary engineering, pipefitting, welding, materials handling operators, and chemical technicians.

The training costs of plant start-up operations are naturally quite high. The responsiveness of federal, state, and local authorities, either through direct subsidies or other training assistance, will certainly aid in minimizing these expenditures and will contribute to the overall profitability of one location over another.

Community Efforts

The pace and timing of community planning efforts are an important, secondary factor in establishing new aluminum facilities. Once again, the industry's experience in West Virginia (see Section IV) highlights the problems and expenses involved when locating in an underdeveloped area. Inadequate housing, school system, and hospital facilities all required industry subsidies. Operating experience indicated a difficulty in retaining technical, professional, supervisory and managerial personnel.

Given two equal choices, the industry will move to the location providing the better community environment. The primary concern in capitalizing on new locational opportunities should be directed toward demonstrating both progress and a progressive attitude in community efforts for improvement. A "grass-roots" motivation in these efforts will be both detectable and impressive to the industry.

Industry likes to locate where it feels welcome. Areas considered likely candidates for new aluminum plants would do well to establish "mobilization" plans covering those problems experienced in West Virginia. Near-term emphasis should be placed on temporary housing, extended medical and educational services, and provisions for extending transportation services. Longer-term plans should include overall land use planning, establishment of permanent and suitable medical and educational facilities, the analysis of potentials for establishing university extension services (if access to higher education is not immediately available), and the development of community cultural and recreational facilities.

Appendix A

Typical job titles and labor classifications in primary aluminum production

Title	Class 1/	Title	Class 1/
Carbon Operations		**Maintenance**	
Carbon mill operator	12	Maintenance mechanic	14
Material equipment operator	8	Pipefitter	13
		Hydraulic specialist	15
Anode pressman	12	Air condtng. specialist	16
Furnace fireman	11	Electrician	16
Laborer - finished carbon	2	Instrument repairman	16
Anode cleaner operator	7	Electronic repairman	18
		Machinist	16
Pot Rooms		Sheet metal worker	15
Sweeper operator	5	Blacksmith	15
Potroom tool repairman	7	Layout man - 1st class	18
Cell operator	10	Machine shop utility man	8
Metal siphoner	11	Roll grinder	12
Anode setter	11		
		Chemical & Analytical	
Power Department		Chemical analyst	8
Rectifier operator	17	Spectrochemical analyst	8
Asst. rectifier operator	12	Materials analyst	8
		Sample preparation man	5
Casting Department		Fluoride analyst	9
DC operator	17	X-ray spectrographer	11
Scale clerk trucker	11		
Pig casting operator	10	**Service & Indirect**	
Rotary furnace operator	12	Storeroom attndt. trucker	8
Flux maker - trucker	9	Receiving & shipping clk.	9
Reclamation molten metal operator	14	Inventory clerk	7
		Stores clerk	7
Casting - utility man	4	Service laborer	1
		Guard-weigher	8
Rolling Department		Alloy scaleman	4
4-Hi mill operator	24	Truck driver	8
Cold mill expediter	10	Craneman - service	8
Furnace operator	12	Inspector	10
Continuous mill operator	23	Power truck operator	8
Hot mill operator	22	Packaging clk. - checker	8
Reheat operator	10	Insp. & loading - utility man	6
Hoistman	7		
Laborer - hot rolling	3	Paper baler	3
Stacker	10	Nailer	4
Marker	4	Lumber tallyman	4

1/ Based on 24 labor grades with 1 representing the low end of the scale

Appendix B

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(6) Labor union contracts.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1967 O - 269-049